Prerequisites for safe driving after brain injury:

Exploring the additional value of BRIEF-A and Awareness Questionnaire in cognitive assessments for holding a drivers' license.

Ann-Marie de Lange Glasø

Hovedoppgave – Psykologisk Institutt

UNIVERSITETET I OSLO

24.10.2012

2012

Prerequisites for safe driving after brain injury: Exploring the additional value of BRIEF-A and Awareness Questionnaire in cognitive assessments for holding a drivers' license.

http://www.duo.uio.no/

Trykk: Reprosentralen, Universitetet i Oslo

Abstract

Author: Ann-Marie de Lange Glasø, 2012

Title: Prerequisites for safe driving after brain injury: Exploring the additional value of BRIEF-A and Awareness Questionnaire in cognitive assessments for holding a drivers' license.

Supervisors: Pål Ulleberg, Associate Professor, PhD, Department of Psychology, UIO

Anne-Kristine Schanke, Professor, PhD, Department of Psychology, UIO

Objective: The present study explores the additional value of BRIEF-A and Awareness Questionnaire in cognitive assessments for holding a drivers' license. The potential additional value of the questionnaires was studied by investigating the statistical correlations between the questionnaires and neuropsychological tests. The relationships between the measures of self-awareness and outcome in the conclusions for or against holding a drivers' license were examined. Furthermore, the relationship between location of injury (left, right or multifocal) and both outcome (fulfilling criteria for driving or not) and self-awareness was investigated.

Research design: Totally, 89 inpatients at Sunnaas Rehabilitation hospital with cerebrovascular accidents (stroke) and traumatic brain injury (TBI) were assessed consecutively using a standardized neuropsychological driving battery. In addition, the patients completed two self-reporting scales, i.e. Awareness Questionnaire (AQ), measuring self-awareness, and Behaviour Rating Inventory of Executive Function (BRIEF-A), measuring executive function in daily life. The questionnaires were *not* part of the basis for the decisions for or against holding a drivers' license. Both questionnaires included corresponding ratings from relatives, and the discrepancy between the patients' and the relatives' scores were calculated and used as an indication of the patients' degree of self-awareness.

Results: Some significant relationships were found between Awareness Questionnaire and neuropsychological tests, predominantly on the Motor/Sensory subscale. Only two weak correlations were found between BRIEF-A and neuropsychological tests. No significant differences were found between the patients fulfilling criteria for driving and the patients *not* fulfilling criteria for driving in terms of self-awareness. Nine patients categorized with impaired self-awareness on Awareness Questionnaire fulfilled the criteria for driving, as did six patients categorized with impaired self-awareness on BRIEF-A. Localization of injury was not significantly related to outcome or measures of self-awareness although there was a tendency for patients with right hemisphere injury to not fulfill the criteria for driving.

Conclusion: The results indicate that both BRIEF-A and the Awareness Questionnaire may serve as valuable supplements in fitness-to-drive assessments, as they seem to measure aspects of higher order cognitive functioning relevant for the ability to adjust driving behavior post injury, which are not covered by neuropsychological tests. Long-term follow-up accident studies should be conducted with large groups of subjects who are assessed comprehensively in order to establish more evidence-based guidelines. The contribution of self-awareness as part of the prerequisites in decision-making for holding a drivers` license should be given attention.

Acknowledgement

As part of the professional study in psychology, I was deployed at Sunnaas Rehabilitation Hospital in 2011. During the internship, I was involved in a large number of neuropsychological assessments carried out with the purpose of evaluating patients' cognitive fitness for holding a drivers' license. It soon became apparent to me that such decisions largely involve risk-assessment, and that the conclusions are of high importance for public health. After having met a very diverse group of patients who displayed various cognitive deficits, one aspect of impaired cognitive function aroused my curiosity greatly: Impaired self-awareness, or the lack of ability to recognize and assess ones' cognitive limitations accurately. Impaired self-awareness is of particular interest in relation to safe driving, as driving with impaired cognitive function requires adaptation of driving behaviour depending on deficits. My interest in the phenomena of impaired self-awareness resulted in the present paper, where impaired self-awareness is explored in relation to fitness-to-drive assessments.

The data used in the present paper were collected in relation to an ongoing PhD study by psychologist Per-Ola Rike at Sunnaas Rehabilitation Hospital in cooperation with Head Psychologist and Professor Anne-Kristine Schanke at Sunnaas Rehabilitation Hospital, Associate professor Maria Schultheis at Drexel University, Philadelphia, and neuropsychologist Anna Lundqvist at the University Hospital of Linköping. I would like to express my gratitude to Per-Ola Rike for including me in his project, and for providing me with support and precise clarifications throughout the process. I would also like to thank my supervisor Pål Ulleberg for invaluable methodological guidance, and my supervisor Anne-Kristine Schanke for crucial feedback, and for continually raising my reflections to a higher professional level during both my internship at Sunnaas and the preparation of this paper.

Ann-Marie de Lange Glasø

Oslo, October 2012

Table of content

1 Introduction

Fitness-to-drive assessments imply complex issues, as injuries or illnesses that affect the brain involve impairment in different cognitive functions varying across individuals, diagnoses, and the nature and extent of injuries. One important aspect of cognition related to safe driving is the ability to recognize one's own level of cognitive functioning. After having met patients who exhibited impaired self-awareness after brain injury, the author's interest in this phenomenon increased greatly. While neuropsychological tests can provide a solid measure of patients' impairment level, they do not measure the patients' self-awareness of level of functioning. Thus, impaired self-awareness can be difficult to detect in standard assessments. The author's clinical experience and interest in the phenomena of impaired self-awareness resulted in the present paper, where impaired self-awareness is explored in relation to fitness-to-drive assessments.

Decisions concerning patients' fitness for driving after acquired brain injury are of importance for public health, considering the high number of people injured in traffic each year: In 2011, 168 people were killed, 679 were severely injured, and 8363 were injured in traffic accidents in Norway (Statistics Norway, SSB). Compared to 2010, the numbers have decreased about 8 per cent, and the long-term trend shows a significant decline in the number of serious injuries and fatalities due to traffic accidents on Norwegian roads. The legislation of seatbelts and enhanced safety design in cars has contributed to reduction of severe injuries (Butcher et al., 2007). However, the incidence of traffic accidents is increasing in developing countries (Finfer & Cohen, 2001), and the World Health Organisation estimates that traffic accidents will be the third leading cause of disability and death worldwide by 2020 (Ad Hoc Committee on Health Research Relating to Future Intervention Options. Investing in Health Research and Development (Document TDR: Gen: 96.1). Geneva: World Health Organisation, 1996, as cited in Finfer & Cohen, 2001). Hence, safe driving and reducing accidents is of profound importance in our society today.

Traumatic brain injury (TBI) remains the leading cause of disability and death in young adults in western countries, where traffic accidents contribute (Maas, Stocchetti & Bullock, 2008). In addition to causing mortality, TBI often result in long-lasting functional impairments in survivors (Finfer & Cohen, 2001). However, improvements of technical adaptations in cars enable people with severe physical injuries to drive, and the prevalence of

TBI survivors who resume driving is around 50 % (Tamietto et al., 2006; Van Zomeren, Brouwer & Minderhoud, 1987). As with TBI, cerebrovascular accidents (stroke) can cause cognitive impairments that might influence the ability to drive safely (Marshall et al., 2007). Many stroke patients experience persisting impairments, yet around 30 -50% resume driving (Coleman Bryer, Rapport & Hanks, 2005 as cited in Scott et al., 2009; Fisk, Owsley & Pulley, 1997). For many adults who have suffered from brain injury, resuming driving is an important aspect of restoring back to a normal life. However, this constitutes an issue of public health and safety considering the number of people involved in traffic at all times (Tamietto et. al, 2006).

While some studies have observed no significant differences in the likelihood of accidents between post-brain injury drivers and healthy controls (Haselkorn, Mueller & Rivara, 1998; Schulteis, Matheis, Nead & DeLuca, 2002), other studies have demonstrated significantly higher risk of being involved in traffic accidents after having suffered from brain injury (Bivona et al., 2012; Formisano et al., 2005; Neyens & Boyle, 2012; Schanke, Rike, Mølmen & Østen, 2008). So far, there are no official statistics documenting the number of people in Norway who, after brain injury, are involved in traffic accidents after resuming his or her driving licence. However, a study conducted by Schanke et al. (2008) which included former stroke and TBI patients assessed for fitness to drive at Sunnaas Rehabilitation Hospital in Norway, showed that the TBI group had an accident rate 3 times higher than the matched normal population 6-9 years post-injury, while the stroke group showed accident rates within a normal range. However, both stroke and TBI often involve cognitive impairments that presumably may affect the ability to drive safely (Finfer & Cohen, 2001; Marshall et al., 2007), as safe driving performance is a complex process that depends on an interaction of motor, perceptual, sensory and visual skills in addition to a variety of cognitive abilities (Smith-Arena, Edelstein & Rabadi, 2006). High information processing speed, selective attention, working memory, inhibition, initiation and decision making are all important aspects of driving. To some extent, driving is an over-learned thus automated process where driving behaviour corresponds to routine activities. However, when unexpected situations occur, as often in traffic, a shift from automated processes to controlled, executive functions is necessary (Lundquist, 2001). Being able to judge the situation, act appropriate and continue to drive safely requires such higher order cognitive abilities as mentioned above.

Michon (1985) describes driving performance as problem solving in a hierarchical, interconnected structure. The *operative level* requires the driver to react instantly in terms of handling the car, for instance by calculating braking speed and distance. The *tactical level* requires information processing about other drivers, evaluation of complex traffic situations as well as flexibility, planning and adaptation within a limited timeframe, which requires adequate judgement, focused attention, inhibition of distracters and realistic awareness of self (Tamietto et al., 2006). The *strategic level* implies that the driver makes decisions related to driving without time constraint, e. g., evaluating which road is safest when slippery or whether he or she will drive when tired. By making adequate strategic decisions, for example avoiding rush-hour traffic, a driver can compensate for lower level cognitive impairments. Management of possible danger depends on risk acceptance (Tamietto et al., 2006). Thus, the tactical and strategic level relies on metacognitive self-reflection, and requires awareness of own driving performance and cognitive function (Lundquist & Alinder, 2007). Brain injury may impair these functions in different ways, and accordingly affect the ability to drive safely.

The first section in this paper gives a brief overview of fitness-to-drive assessments. The paper further provides a clarification of the construct of *self-awareness* as an aspect of 'higher cognitive abilities', related to the importance of this concept in safe driving. The relationship between measures of self-awareness and neuropsychological data is statistically investigated in the context of fitness-to-drive assessments, followed by an examination of localisation of injury in relation to self-awareness and outcome (fulfilling criteria for driving or not). Finally, the paper provides a discussion of the findings including methodological issues and implications, and gives recommendations for future research.

1.1 Assessment of fitness to drive

Within the legal requirements of the Norwegian Directorate of Health, resuming driving after having suffered a disease, such as brain injury, demands that the patient meets the health requirements for driving (Forskrift om førerkort m.m. nr. 298, 2004). Physicians, psychologists and optometrists are legally obliged to notify authorities in cases where a patient does not fulfil the health requirements for driving (Helsepersonelloven § 34, 1999), and the condition is expected to have a duration of six months or more (Forskrift om helsekrav til bilførere mv, nr. 1467, 1984). In cases of doubt after medical assessments, the

General Practitioner (doctor) may refer to comprehensive multimodal fitness-to-drive assessments, which often includes on-the-road driving assessments in addition to cognitive assessments. The Norwegian authorities specify the criteria for holding a driver's license, but assessments conducted in Norway most likely show great variability (Schanke & Sundet, 2000). To avoid unequal patient treatment, best practice guidelines for fitness-to-drive assessments have recently been developed (Norsk Psykologforening, 2012). Although the health requirements for driving (Forskrift om førerkort m.m. nr. 298, 2004) includes clinical populations that constitute risk groups, there is no systematic enumeration of *symptoms* that may interfere with the health requirements. Hence, the best-practice guidelines include cognitive impairments such as neglect, apraxia, agnosia, visuospatial impairment, prolonged reaction time, reduced judgment and reduced self-awareness as symptoms considered contrary to safe driving (Norsk Psykologforening, 2012). However, various diagnoses make fitness-to-drive assessments problematic and challenging. While lateralized brain injuries from stroke can result in focal deficits such as neglect, aphasia or apraxia, multi-focal injuries from TBI often create diffuse cognitive outcomes including impaired executive function and metacognition. Impairments in such higher order cognitive abilities are often associated with frontal lobe injuries. However, injury in other regions of the brain due to stroke or TBI may also result in such deficits (Stuss & Levine, 2002) because of diffuse axonal injury (Xu, Rasmussen, Lagopoulos & Håberg, 2007) which might disrupt structural and functional connections within neural networks (Sharp et al., 2011). Deficits in higher order cognitive abilities, such as reduced self-awareness, are difficult to assess and measure with neuropsychological tests as such assessments are standardized and time limited.

In fitness-to-drive assessments, one procedure has been employing neuropsychological tests as a basis for assessing cognitive ability to drive, within the framework of the health requirements for driving. However, standardized neuropsychological assessments measure cognitive functions equivalent to the operational and to some extent the tactical level of driving, and the assessment does not entirely include all aspects of driving performance, such as self-awareness and the patients' ability to cope with cognitive impairment on a strategic level (Lundquist & Alinder, 2007). Research emphasizes, in addition to medical data and cognitive function, that personality factors, previous driving behaviour and self-awareness should be taken into account as essential factors when considering someone's ability to drive safely after brain injury (Tamietto et al., 2006). Accordingly, a study by Pietrapiana et al. (2005) on patients with TBI (N =66), showed that premorbid factors such as pre-injury personality traits and pre-injury driving style explained up to 72% of the driving performance post-injury evaluated by traffic rules violations and accidents. In addition, these premorbid factors turned out to be better predictors than neuropsychological, medical, biographic and demographic measures in the same sample. Patomella, Kottorp and Tham (2008) conducted a study to investigate awareness of driving disability in stroke patients (N=38). The awareness of driving disability was measured by the calculated discrepancy between self-reported driving ability and observed driving actions in a driving simulator. The result showed that the patients who scored below cut off criterion for the driving evaluation also had limited awareness of their driving disability. Scott (2010) found similar results showing that stroke patients who overestimated their cognitive function predicted their driving ability less accurate and performed worse in a driving simulator than the patients who exhibited intact self-awareness. A study by Griffen, Rapport, Coleman Bryer, Bieliauskas & Burt (2011) found that patients with impaired awareness after acquired brain injury had less success on an on-road driving evaluation than their counterparts with intact self-awareness. Furthermore, the results showed that when self-awareness of impairments increased, driving improved. Thus, self-awareness should be considered an important aspect in fitness-to-drive assessments. However, the number of studies that have included measures of self-awareness when investigating critical factors for safe driving are limited, and more research is highly needed to enable an understanding of the relevance of self-awareness in driving. Furthermore, the lack of consensus in the international field of study makes comparisons difficult, as assessment methods and outcome measures are highly varied. However, standardized neuropsychological and medical measures mostly account for domain-specific areas of cognitive function and perceptual motor skills corresponding to the operational and some extent tactical level, and as such, do not include all aspects of safe driving such as premorbid personality or self-awareness. Recent empirical research, however, clearly indicate a need to address such factors as well in driving evaluations.

1.2 Executive function, Metacognition and Self-Awareness

The *executive functions* comprise the capabilities that enable a person to engage in goal directed, independent behavior (Lezak, 2004). Executive functions include a range of cognitive processes such as planning, problem solving, multitasking, the ability to manage novelty and cognitive flexibility (Burgess, Veitch, de lacy Costello & Shallice, 2000; Grafman & Litvan, 1999; Lezak, 2004; Stuss, Shallice, Alexander & Picton, 1995), and are, by such, considered essential in safe driving performance (Schanke & Sundet, 2000). Executive functions also include components of behavioral and 'emotional' processes such as decision-making involving emotional interpretation, the experience of reward and punishment, and regulation of social behavior (Anderson, Anderson, Northam, Jacobs & Mikiewicz, 2002; Bechara, Damasio, Damasio, & Lee, 1999; Bechara, Tranel, Damasio & Damasio, 1996). Various definitions abound for the concept of executive functions, and despite the consensus regarding executive functions' significance for human adaption there is a lack of clarity about the terms, components and the variables that measures them (Jurado & Rosselli, 2007).

Executive functions are often referred to as 'higher order cognitive abilities' along with *Metacognition* (Chiu, Carlson, Arnett, Consentine & Hillary, 2011), which involves the ability to hold the track of one's own cognitive processes. Fostering evaluative judgements of mind-content such as attitudes, beliefs, experiences and desires is necessary for guiding one's decisions and behaviour, as well as understanding other's mental states (Schmitz, Kawahara-Baccus & Johnson, 2004). Metacognition includes both *metacognitive knowledge*, which refers to stored beliefs and knowledge about one's cognitive abilities, strategies and tasks that guides cognitive operations, and *metacognitive experience* pertaining the monitoring that occurs in the moment of cognitive engagement (Flavell, 1979). Metacognitive monitoring refers to awareness of one's performance during a task, whereas behavioral regulation, a concept often associated with the executive functions (Anderson, et al., 2002; Gioia & Isquith, 2004; Gioia, Isquith, Guy, & Kenworthy, 2000), reflects the ability to adjust and change strategies to improve performance as a response to task demands (Toglia & Kirk, 2000). It has been suggested that behavioral regulation depends on accurate metacognitive monitoring or awareness (Borkowski, 1996), and that metacognitive judgments influence the exertion of executive control over behavior. In accordance, some research has demonstrated a relationship between behavioral adjustments and judgments of performance (Karpicke, 2009), and correlations between poor performances on executive tasks and reduced metacognitive awareness have been found (Bivona et al., 2008; Ciurli et al., 2010). In this respect, metacognition are closely related to executive function. However, research findings are highly varied, and while some studies have revealed significant correlations between metacognition and executive function (Karpicke, 2009; Lysaker et al., 2008), others have failed to demonstrate consistent relationships (Chiu et al., 2011; Erez, Rothschild, Katz, Tuchner & Hartman-Maeir, 2009). Some argue that these constructs may be related but still have divergent demands and unique characteristics (Chiu et al., 2011).

Although many researchers emphasize the similarity between components of executive function and metacognition (Fernandez-Duque, Baird & Posner, 2000; Shimamura, 2000), these are often presented as two separated constructs in the literature, which might reflect the variation of research methods and the challenges related to measuring these abilities. However, models of executive function and metacognition both include higher order cognitive processes that control and monitor more basic information processing (Chiu et al., 2011), and there are evidence of overlapping neural networks engaging in metacognitive- and executive tasks (Stuss, 2011). The ambiguity comprising these higher order cognitive functions also applies for the concept of *self-awareness*, which is often related to executive functions within neuropsychology, and associated with metacognition in cognitive psychology (Toglia & Kirk, 2000). Various terminology derived from different perspectives has led to substantial challenges regarding the understanding of self-awareness, and the literature is characterized by a range of research approaches and inconsistent findings. However, while executive functions remain imprecisely defined, most researchers include metacognitive skills such as self-monitoring among the components (Hart, Whyte, Kim & Vaccaro, 2005). In the present paper, self-awareness is regarded as an aspect of metacognition, and related to executive function mainly due to the relevance of both executive function and self-awareness in driving.

Regardless of the discussion concerning the relationship between executive function, metacognition and self-awareness, there is consensus about self-awareness, or an adequate understanding of one's own level of functioning, as an important aspect of higher order cognitive functions (Ciruli et al., 2010; Prigatano, Altman & O'Brien, 1990; Toglia & Kirk, 2000). In clinical neuropsychology, the term self-awareness broadly refers to the ability to recognize impairments in functioning caused by brain damage (Ciruli et al., 2010). Prigatano & Schacter (1991, as cited in Prigatano & Klonoff, 1998) defines impaired self-awareness as impairment in the ability to consciously perceive and experience disruption in higher cerebral functioning. Impaired self-awareness of own deficits is a common sequaele of acquired brain injury (Hartman-Maeir, Soroker, Ring, & Katz, 2000; Sherer, Hart, Whyte, Nick & Yablon, 2005; Starkstein, Jorge, & Robinson, 2010), and the importance of understanding this phenomenon is highly emphasized, as research indicates that impaired self-awareness often influence rehabilitation outcome (Ekstam, Uppgard, Kottorp, & Tham, 2007; Sherer, Bergloff, Levin et al., 1998).

Early models emphasized that the construct of self-awareness includes different components. Crosson et al. (1989) divided self-awareness into the following areas: *Intellectual awareness*, representing the patients' ability to describe their impaired functioning; *emergent awareness*, referring to the ability to recognize the problems as they occur; and *anticipatory awareness*, which refers to the patients' ability to predict when problems caused by their deficits will arise. As an extension of Crosson et al.'s model, Toglia & Kirk (2000) proposed a comprehensive framework, which deals with the concept of self-awareness as a dynamic process rather than distinct, hierarchical levels. The model differentiates between *metacognitive knowledge* about ones abilities, which includes intellectual awareness, and *online awareness* of performance during tasks, including elements of both emergent awareness and anticipatory awareness. In relation to Michons' model of safe driving performance (1985), intellectual awareness is relevant to driving at the operational and to some extent the tactical level, while emergent awareness is relevant to driving at the tactical level. Anticipatory awareness is crucial when operating on the strategic level.

Toglia & Kirk's model (2000) further differentiates between *pre-existing* beliefs and knowledge about oneself, and knowledge that are *activated during a task*. The concept pre-existing knowledge is a result of repeated experiences over time and are, as such, relatively stable (Brown, 1987, as cited in Toglia & Kirk, 2000). The term online awareness includes the ability to monitor behaviour and performance within action (Hart, Giovannetti, Montgomery & Schwartz, 1998), and varies depending on task and situation. Thus, online awareness is relatively unstable in contrast to pre-existing knowledge (Brown, 1987, as cited in Toglia & Kirk, 2000). Pre-existing knowledge influences self-awareness within the context of a situation or a task, and the results of self-monitoring activities interacts with pre-existing knowledge by being compared to expectations based on earlier experiences. The discrepancy between what one *expects to do* and what one *actually does* may result in adjustment of behaviour and change in strategy. Eventually, the perception of the outcome, within the context of a particular situation, may restructure the beliefs and knowledge about one's abilities (Flavell, Miller & Miller, 1993, as cited in Toglia & Kirk, 2000). As such, this model includes the importance of self-awareness for the ability to develop compensatory strategies, or *coping*, which is a decisive aspect of driving after having suffered from brain injury resulting in impaired cognitive functions. Coping is related to the strategic level of driving performance, hence, a driver can compensate for lower level cognitive impairments making adequate strategic decisions like avoiding rush-hour traffic. Furthermore, the constant dynamic interaction between pre-existing knowledge and on-line awareness proposed in this model includes an explanation of how the perception of one's abilities interacts with performance on different tasks and varies depending on contexts and situation. Factors such as personality, culture and task meaningfulness are emphasized as influential (Toglia & Kirk, 2000). As such, online awareness, both emergent and anticipatory, may be evident in some situations but not in others. This highlights the importance of *context* for self-awareness, which is highly relevant in fitness-to-drive assessments, and thus, addressed in section 4.

Another important point in the model is the possible dissociation between intellectual awareness, i.e. recognizing the level of functioning, and emergent and anticipatory awareness, i.e. *the use* of this knowledge to monitor online performance and to predict difficulties that are likely to occur because of the deficit. The dissociation between the components of self-awareness is highly relevant to the ability to drive safely, as the use of intellectual awareness to monitor online performance and to make strategic decisions is essential to driving performance at the tactical and strategic level (Lundquist & Alinder, 2007).

Furthermore, research indicates that patients with brain injury are more accurate in assessing their own limitations regarding easily observable deficits such as physical constraints or daily life activities than deficits in higher order cognitive functions, where impaired self-awareness seems to play a more prominent role (Prigatano, 1996). This implies that patients might have intact awareness regarding their driving performance at the operational level, while they lack accurate awareness of their driving performance at the tactical and strategic level of driving. Although Toglia & Kirk's model (2000) emphasize how the perception of one's abilities interacts with performance on different tasks, and varies depending on contexts and situation, it does not explain the dissociation between awareness of physical impairments and awareness of impairment in higher order cognitive abilities.

To summarize, relating Toglia & Kirk's model of self-awareness (2000) to Michon's three levels of driving (1985), respectively, may contribute to a more specific understanding of the relevance of self-awareness in driving performance. In the present paper, the concepts first described by Crosson et al. (1989), i.e. intellectual, emergent and anticipatory awareness, are used in relation to the levels of driving performance, and regarded as components of self-awareness underlying metacognitive knowledge and online awareness (Toglia & Kirk, 2000). Toglia & Kirk's model (2000) provides clarification around the complexity of the concept self-awareness, and includes the key issue of dissociation between the levels of awareness, an aspect highly relevant to safe driving performance. However, there are limited research methods developed to assess the relevance of such theoretic models, and the potential effectiveness of Toglia & Kirk's theoretical driven approach on assessment and interventions have not yet been systematically evaluated (Fleming & Ownsworth, 2006). Bach and David (2006) underline the major difficulty in understanding the complex construct of self-awareness, and define self-awareness in operational terms "as a process by which an individual is able to rate their behavioural responses (physical, somatic, cognitive and affective) in accordance with ratings with some objective standard, usually from an informant, who knows the individual well" (p. 398). The operationalization of the concept of self-awareness is based on the most commonly used method for examining self-awareness in patients with brain injury (Fleming, Strong & Ashton, 1996) which will be described in section 1.3.

1.2.1 Neural correlates of Executive function and Self-Awareness

In the quest for the understanding of higher order cognitive abilities, researchers from various disciplines have embarked upon the study of the neural mechanisms underlying executive function and the capability to generate metacognitive evaluations of oneself. Both neuroimaging studies and lesion studies have contributed to the current knowledge of the neural activity behind these higher order cognitive functions. The lack of clarity about these concepts and the various methods applied for examining them makes the research literature challenging to summarize. This section presents some essential key findings.

Neuroimaging studies have demonstrated an association between frontal networks and both executive function (Collette, Hogge, Salmon & Van der Linden, 2006; Jurado & Rosselli, 2007) and metacognition (Chua, Schacter, Rand-Giovannetti & Sperling, 2006; Fernandez-Duque et al., 2000). There is a common acceptance that components of executive functions are associated with different areas of the frontal lobes (Stuss & Alexander, 2000), as studies have revealed frontal lobe involvement during a number of executive tasks (see Jurado & Rosselli, 2007 for an overview). However, there is an emerging consensus that the central involvement of the frontal lobes is a part of functionally independent, but closely interacting networks including thalamic pathways and subcortical structures (Fernandes-Duquet et al., 2000; Lewis, Dove, Robbins, Barker, & Owen, 2004; Løvstad et al., in press). Thus, many current researchers focus on the *connectivity,* or neural circuits between these areas rather than the specific structures in relation to different aspects of executive function (Royall et al., 2002). However, the specificity of neural networks and structures involved in executive function are still subject to uncertainty.

The evidence on the neural correlates of self-awareness from functional imaging studies conducted on healthy subjects is limited (Johnson et al., 2002). So far, recent studies examining metacognitive evaluations have converged on the medial prefrontal cortex (MPFC) as an important part in a neural system involved in self-awareness (Johnson et al., 2002; Kelley et al., 2002; Schmitz et al., 2004). In an event-related fMRI study, Kelley et al. (2002) found greater activation in areas including the anterior cingulate and the left inferior frontal cortex when comparing 'self'- and 'other judgements' with a third condition; 'case judgements'. The results further revealed evidence of significant higher activation in the MPFC and the posterior cingulate during the condition 'self-judgements' when directly compared to the two other conditions, suggesting that these areas may play an important role in metacognitive evaluations of self. Importantly, the activation in these regions *decreased* when all encoding trials were contrasted with baseline activity across all participants, indicating that the observed positive activity actually resulted from the difference between two decreases relative to baseline. Interestingly, the activity in MPFC was markedly reduced relative to baseline during both 'other'- and 'case judgements', whiles the 'self-judgement' condition gave a much weaker decrease in the MPFC. Typically, in research, responses in MPFC are referred to as an increase in brain activation relative to baseline (Kelley et al., 2002). However, responses in MPFC are usually observed as decreases in activity relative to baseline (Gusnard & Raichle, 2001). Consistent with the evidence of high baseline metabolic activity in the MPFC at rest (Raichle et al., 2001), it has been suggested that the MPFC is involved in a baseline default mode of brain function exhibiting task-related decreases in brain activity (Shulman et al., 1997). I.e., self-relevant mental activity is part of the brain's default, or spontaneous mental activity, which is present in the absence of external information processing. Thus, when participants are engaged in externally directed decisions, the MPFC are suspended, resulting in decreased activation, and when participants engage in self-relevant decisions the activity in MPFC reflects the default MPFC activity at rest (Kelley et al., 2002).

Lesion studies have been conducted on samples with specific deficits such as anosognosia for hemiplegia (Marcel, Tegner & Nimmo-Smith, 2004; Moro, Pernigo, Zapparoli, Cordioli & Aglioti, 2011) and degenerative diseases such as Alzheimer's (Harwood et al., 2005; Rosen et al., 2010; Salmon et al., 2006), showing mixed findings varying largely across diagnoses. Confined to the relevance of the sample in the current study, impaired self-awareness has been associated with right-hemisphere lesions involving both cortical structures (temporal, insular and parietal lobes) and sub-cortical structures (basal ganglia and thalamus) in stroke patients (Starkstein et al., 2010), while research on TBI patients emphasizes the relevance of prefrontal cortex in self-awareness (Consentino & Stern, 2005). Consistent with the functional imaging data on healthy subjects, an fMRI study conducted by Schmitz, Rowley, Kawahara & Johnson (2006) indicated that frontal networks, specifically MPFC and retrosplenial cortical regions, were involved in self-awareness in TBI patients. Sherer et al. (2005) emphasize that rather than focal lesions, broadly distributed networks may be damaged in cases of impaired self-awareness. However, the neural networks related to executive function, metacognition and self-awareness are not yet completely understood in regards to specificity and extent. Accordingly, research including the factor of severity of brain injury show inconsistent results (Leathem, Murphy & Flett, 1998; O'Keeffe, Dockree, Moloney, Carton & Robertson, 2007).

Importantly, neural deficits are not the only emphasized factor related to impaired self-awareness. The psychological factor *denial*, a defence mechanism conceptualized by Freud (1938, as cited in Prigatano & Klonoff, 1998), and defined as 'an automatic psychological process that protects the individual against anxiety and from awareness of internal or external stressor or dangers' (American Psychiatric Association, 1994, p. 765) stands out as particularly relevant to impaired self-awareness (Ownsworth, McFarland & Young, 2002). In the early psychiatric literature, it was emphasized that the symptoms of impaired self-awareness might reflect emotional disturbances (Prigatano & Klonoff, 1998), and not only direct sequelae of brain injury as assumed in the early neurological tradition. Consequently, Frederik (1969, as cited in Cutting, 1978) divided the phenomena of self-awareness into 'anosognostic behavioral disturbances' and 'explicit denial', emphasizing that one should not confuse denial of illness with impaired self-awareness of illness, or anosognosia. He further suggested the former to be understood in psychological terms and the latter in neurological terms (House & Hodges, 1988). However, current evidence show that anosognosia and emotional denial tend to re-occur (Kortte, Chwalisz & Wegener, 2003), which makes a clear distinction difficult to determine.

In summary, the neural correlates and mechanisms underlying self-awareness are not yet clearly understood (Rosen, 2011). As recent evidence suggests that neural contingent deficits in self-awareness and denial do seem to re-occur (Kortte, Chwalisz & Wegener, 2003), the relative contribution of psychological and neuropsychological factors on impaired self-awareness should be emphasized (Ownsworth et al., 2002). However, this is beyond the scope of the current study. Although there is an increasing focus on widespread neural networks in relation to higher order cognitive abilities (Fernandes-Duquet et al., 2000; Lewis et al., 2004; Løvstad et al., in press), impaired awareness has been associated with right-hemisphere lesions in stroke patients (Starkstein et al., 2010) and with prefrontal deficits in TBI patients (Consentino & Stern, 2005; Schmitz et al., 2006). In the present study, localization of injury is categorized as left hemisphere injury, right hemisphere injury, multifocal injury and cerebellum/pons injury, with the intent to explore the relationship between localization of injury and self-awareness.

1.2.2 Impaired Executive function, Self-Awareness and driving

Technical adaptations in cars enable driving with severe physical injuries, and as such, ease the driving performance on the operational level for patients resuming driving after brain injury. Furthermore, patients' seem to assess their physical limitations more accurately compared to impairments in higher order cognitive functioning (Bach & David, 2006; Prigatano, 1996), which implies that the tactical and strategic level of driving are of profound importance. Driving at the tactical level, i.e. managing the complexity and unpredictability characterizing traffic situations, require a range of executive functions such as multitasking, inhibition, initiation and immediate decision making (Lundquist, 2001) in addition to self-monitoring of driving performance and awareness of one's cognitive function (Lundquist & Alinder, 2007). Self-monitoring requires substantial attention to both the task and own performance, and it has been suggested that impairments in executive components involving control over complex attention, or multitasking, can contribute to reduced self-awareness (Hart et al., 2005). As such, impairments in executive function itself constitute a significant threat to safe driving performance on the tactical level as it relates to emergent awareness, i.e. reduced ability to self-monitor as problems occur.

Patients lacking anticipatory awareness may fail to use the awareness of their own cognitive impairments to predict possible difficulties that are likely to occur (Toglia & Kirk, 2000). Thus, impaired anticipatory awareness affects the ability to develop coping strategies on the strategic level, such as not driving in darkness or avoiding rush-hour traffic (Lundquist & Alinder, 2007). However, strategic planning also relies on executive function; thus, impairments in executive functions and self-awareness both constitute a threat to the use of compensatory strategies at tactical and strategic levels when driving (Lundberg, Caneman, Samuelsson, Hakamies-Blomquist & Almkvist, 2003). A study conducted by Schanke et al. (2008), showed that a group of stroke patients had changed their driving patterns and reduced their driving post-injury, while no changes were found in driving patterns in the TBI group. However, there were no significant differences in *perceived* driving skills between the groups. These results may indicate a higher degree of risky driving behaviours within the TBI group, and might reflect a possible lack of compensation strategies in the TBI group in spite of self-awareness as to the cognitive deficits. In addition, the members of the TBI group had different premorbid characteristics and were younger than the stroke group. In other words, self-awareness is essential, but apparently not sufficient for safe driving. Furthermore, the use of compensatory strategies requires both awareness of disabilities and *willingness* to cope, and are, by such, closely related to psychological factors (Lundquist & Alinder, 2007). A study by Ownsworth et al. (2002) found that patients who presented their personality in a favourably light were more likely to use denial as a coping strategy after brain injury. The social desirability level was not related to personality disturbance post-injury, indicating that pre-morbid factors might be of importance in denial. Although the impact of these factors is beyond the scope of this paper, they may affect the development of compensational strategies related to driving, which confirms the importance of including pre-morbid factors and psychological factors in the basis for understanding self-awareness.

Considering the complex composition of higher order cognitive functions underlying safe driving on the tactical and strategic level, executive functions and self-awareness are highly relevant aspects that should be of consideration in fitness-to-drive assessments. Furthermore, another concept, namely *self-awareness of executive functions,* seems reasonable to take into account. However, no previous studies have, to the author's knowledge, investigated self-awareness of executive function in the context of fitness-to-drive assessments. Therefore, the Behaviour Rating Inventory of Executive Function-Adult version (BRIEF-A) was included in the current study as a measurement of both self-reported executive impairment, and a measure of self-awareness of executive function. The method is described in section 1.3.

1.3 Measuring executive functions and Self-Awareness

Generally, the study- and assessment of impaired executive function face inherent challenges in terms of valid and accurate assessment. Executive functions are part of a complex system consisting of cognitive, affective, motivational and behavioral components (Bivona et al., 2008), and impairment in any component process is difficult to rule out (Chan, Shum, Toulopoulou & Chen, 2008). Consequently, there is no unified test for executive functions, and the existing neuropsychological tests have been proposed to measure single components (Bivona et al., 2008). Another major issue related to neuropsychological tests of executive function is ecological validity, which refers to the generalizability of results from test performance to performance in the real world (Chaytor & Schmitter-Edgecombe, 2003).

Executive functions coordinate one’s behavioural and cognitive abilities with the demands of real world situations (Gioia & Isquith, 2004). Thus, neuropsychological tests of executive function have been questioned (Gioia & Isquith, 2004), as the assessment situation in itself provides structure, organizing and monitoring. Thus, the test situation may “take over” the patients’ executive functions (Stuss & Alexander, 2000), which reduces the possible observation of critical behaviours associated with impaired executive functions (Stuss, 1987). In this regard, many patients perform within normal range on tests of executive function, but experience substantial difficulties in their lives outside the test-situation (Stuss & Buckle, 1992). Considering the importance of executive functions in safe driving, this is a cause of concern in fitness-to-drive assessments. Accordingly, some researchers stress the importance of developing new measures of executive functions based on an ecological approach. The Behaviour Rating Inventory of Executive Function-Adult version (BRIEF-A), a self-report questionnaire measuring executive function in daily life, was developed from an ecological perspective (Gioia & Isquith, 2004). BRIEF-A is presumed to detect executive impairment which might not be detected through neuropsychological tests (Løvstad et al., in press). Thus, the use of BRIEF-A has been argued to increase ecological validity in assessments of executive function (Gioia & Isquith, 2004). So far, few studies have examined the relationship between BRIEF-A and neuropsychological measures. The existing research report few, or none significant correlations, indicating that BRIEF-A taps different constructs within executive functions than the neuropsychological tests measure (Anderson et al., 2002; McAuley, Chen, Goos, Schachar & Crosbie, 2010; Løvstad et al., in press). However, the ecological validity of BRIEF-A itself is not yet empirically established. In addition, a study revealed robust correlations ($r =, 64\text{-}.98$, $p < 0{,}001$) between the BRIEF-A Global Executive Composite score and the Global severity Index of the Symptom checklist 90 revised (SCL-90-R, a widely used questionnaire measuring psychological problems and symptoms of psychopathology), indicating that BRIEF-A might be associated with general emotional distress, and thus may not be specific to executive function (Løvstad et al., in press).

Unlike domain-specific cognitive functions, measures of self-awareness are often derived from observations, questionnaires or interviews. A number of scales and measurements have been developed to assess self-awareness in brain-injured patients, and assessment designs vary from semi-structured interviews to self-report questionnaires (Bach & David, 2006). The most frequently used method for measuring self-awareness involves comparison of patients’ self-rating with another measure considered more objective (Fleming et al., 1996). Deaton (1986) differentiated between the following three such methods of assessment: (1) the discrepancy between patients' self-rating and the families' rating of the patient; (2) the discrepancy between patients' self-rating and the rehabilitation staffs' rating of the patient; and (3) The discrepancy between the patients' estimates of their own abilities and performance on neuropsychological tests.

The Behaviour Rating Inventory of Executive Function, adult version (BRIEF-A) includes both self-reporting and family/clinician rating forms, which enables the calculation of discrepancy scores. Considering how self-awareness is associated with metacognition and executive function, these discrepancy scores might shed light on level of self-awareness of executive function. A commonly used measure of impaired self-awareness is the Awareness Questionnaire (AQ), developed by Sherer, Bergloff, Boake, High Jr. and Levin (1998) as a measure of impaired self-awareness after TBI. The AQ enables the use of a total discrepancy score as a measurement of the patients' degree of self-awareness, and can further differentiate between aspects of awareness by the three subscales divided in to Motor/Sensory, Cognition and Behavioural/Affective (Sherer, Hart & Nick, 2003). Thus, the combination of these two questionnaires may provide information about several aspects of self-awareness, including self-awareness of executive function.

Furthermore, investigating the relationship between executive functions and self-awareness is of interest, as previous studies lack consistent findings. While some studies have found significant correlations between metacognitive self-awareness and some components of executive function, such as flexibility, problem solving, inhibition of response and high percentage of perseverative errors (Bivona et al., 2008; Circuli et al., 2010), other studies have failed to demonstrate correlations between executive dysfunction and reduced self-awareness (Back & David, 2006). As neuropsychological tests do not measure self-awareness directly, impaired self-awareness can be difficult to detect for clinicians due to the limited information about the patients' premorbid function, personality and everyday behaviour. Although the importance of self-awareness for safe driving after brain injury is highly emphasized in the literature, measurements of self-awareness are not an established part of fitness-to-drive assessments in Norway. Consequently, standard neuropsychological assessments may not only fail to reveal the various impairments in higher order cognitive abilities, but the patients' self-awareness of such impairments may also stay undiscovered.

The inclusion of discrepancy scores on both BRIEF-A and Awareness Questionnaire (AQ) in the current study provides a comprehensive measure of self-awareness where several aspects are included. The applied measures of self-awareness are based on the operational concept, assuming that the discrepancy between patients' self-rating and relatives' ratings can provide a measurement of impaired self-awareness (Bach and David, 2006). It is assumed that relatives' ratings contain valid information as their observations of the patient is far more frequent than the clinicians', and includes aspects of premorbid function that clinicians have limited access to. However, the use of self-reporting and discrepancy ratings does provide methodological issues, especially in the setting of fitness-to-drive assessments, which provides a context where one would expect some patients and relatives to underreport deficits. These issues are discussed in section 4.1.

1.4 The purpose of the present study: Objectives and research hypotheses

This paper seeks to explore the additional value of measuring self-awareness in cognitive assessments for holding a drivers' license. To the authors' knowledge, no previous studies have included BRIEF-A as a measure of self-awareness of executive function in relation to fitness-to-drive assessments, and only few studies have included the Awareness Questionnaire (AQ) when investigating factors relevant for safe driving (Griffen et al., 2011; Scott, 2010).

Objective I: The first objective of the study is to investigate the concurrent validity of BRIEF-A as a measure of self-awareness of executive function, i.e. whether the BRIEF-A discrepancy scores correlates with the discrepancy scores of the Awareness Questionnaire.

Hypothesis 1: The discrepancy scores on BRIEF-A and AQ will correlate, supporting the concurrent validity of BRIEF-A as a measure of self-awareness of executive function.

Objective II: Second, the potential additional value of the questionnaires is examined, i.e. whether AQ and BRIEF-A measure other factors than the neuropsychological tests do. In accordance with the research showing that patients' more accurately assess their own limitations regarding physical constraints than higher order cognitive functions (Bach & David, 2006; Prigatano, 1996), it is hypothesized that patients' ratings on the Motor/Sensory subscale on AQ will be related to performance on tests of sensomotoric coordination. No additional correlations are expected. Lack of significant correlations between BRIEF-A and cognitive tests is expected in accordance with previous research (Anderson et al., 2002; McAuley et al., 2010; Løvstad et al., in press).

Hypothesis 2.1: Patients' ratings on the Motor/Sensory subscale on AQ will be related to performance on tests of sensomotoric coordination.

Hypothesis 2.2: Lack of significant correlations between BRIEF-A and cognitive tests is expected.

Objective III: The third objective is to investigate whether the measures of self-awareness were related to outcome (fulfilling the criteria for driving or not) i.e. if the measures can predict the outcome in the conclusions for or against holding a drivers' license in the current sample.

Hypothesis 3: The measures of self-awareness cannot predict the outcome, as neuropsychological tests are the basis of the decisions and these do not include measures of self-awareness.

Objective IV: Finally, the study examines the relationship between location of injury (left, right or multifocal) and both outcome (fulfilling the criteria for driving or not) and self-awareness. Impaired self-awareness has been associated with right-hemisphere lesions in stroke patients (Starkstein, et al., 2010), and multifocal lesions involving prefrontal cortex in TBI patients (Consentino & Stern, 2005, Sherer et al., 2005).

Hypothesis 4: Patients with multifocal or right hemisphere injuries will score higher in terms of impaired self-awareness compared to patients with left hemisphere injuries.

2 Method

The data were obtained from an ongoing PhD study by Rike (2011), approved by the Helsinki Declaration and Vancouver rules and the Regional Committee for Medical research ethics (REC), South East, Norway. All data were made anonymous for use in the present study.

2.1 Sample and procedure

The sample consisted of 89 inpatients at Sunnaas Rehabilitation Hospital with stroke or TBI, mainly inhabitants` in the geographical area of the South-Eastern Norway Regional Health Authority. The patients were referred for fitness-to-drive assessments between March 2010 and March 2011 and those who fulfilled the inclusion criteria were consecutively included in the study. The Inclusion criteria were cerebrovaskular accident (stroke) or traumatic brain injury (TBI) confirmed by Computerized Tomography (CT) or Magnetic Resonance Imaging (MRI), minimum 3 months post injury, and in need for a driving assessment. Exclusion criteria were extensive aphasia due to brain injury causing potential validity problems during testing, dementia or other somatic or neurological illnesses that might affect cognition, and severe psychiatric illness.

Table 1. *Demographic and medical characteristics of subjects.*

	Stroke	TBI	Total
N (%)	58 (65)	31 (35)	89
Male %	74,1	80,7	77
Age, Mean (*SD*)	57,7 (12,9)	47,4 (16,2)	54,1 (14,9)
Education in years, Mean (*SD*)	12,4 (3,1)	12,9 (2,6)	12,6 (2,9)
Months since injury, Mean (*SD*)	23,8 (28,5)	19,8 (24,7)	22,4 (27,2)
Localization of injury *N* (%):			
Left	21 (36,8)	7 (23,3)	28 (31,5)
Right	25 (43,9)	4 (13,3)	29 (32,6)
Multifocal	6 (10,5)	19 (63,3)	25 28,1)
Cerebellum pons	5 (8,8)	0 (0)	5 (5,6)
Total	57 (98)	30 (97)	87 (97,8)

Note. Missing data on localization of injury: 2 (2, 2 %)

As apparent from Table 1, the group of patients diagnosed with stroke was somewhat larger than the TBI group. 77 % of the participants were male. The mean education level was in excess of 12 years. Months since injury were on average 22, 38. The majority of patients with multifocal injury had suffered from TBI, while the majority of the patients with left and right hemisphere injury had suffered from stroke. All patients with cerebellum/pons injury had suffered from stroke.

Table 2. *Localization of injury and decision of resuming a drivers' license.*

Localization of injury:		Fulfilled criteria for driving **No**	**Yes**	Total
Left	*n*	12	16	28
	%	42,9%	57,1%	100,0%
Right	*n*	19	10	29
	%	65,5%	34,5%	100,0%
Multifocal	*n*	12	13	25
	%	48,0%	52,0%	100,0%
Cerebellum Pons	*n*	0	5	5
	%	0,0 %	100%	100%
Total	*n*	43	44	87
	%	52,4%	47,6%	100,0%

Note. Missing data on localization of injury: 2 (2, 2 %)

Table 2 shows the number and percentage of patients in the groups categorized by localization of injury that fulfilled criteria for driving or not.

The participants underwent a neuropsychological and medical assessment (see Sundet, Goeffeng & Hofft, 1995 for full procedure). The patients passing the medical and neuropsychological examinations, or when doubt on ability to drive safely, were referred to an on-road driving test conducted between March 2010 and March 2011. In addition to standardized neuropsychological tests, two questionnaires, Awareness Questionnaire (AQ) and the Behavior Rating Inventory of Executive function, Adult version (BRIEF-A) were administered to both patients and a significant other/close relative of the patient. To minimize validity threats in terms of underreporting and social desirability, all participants were explicitly made aware that Awareness Questionnaire and BRIEF-A were not part of the conclusion. A professional driving instructor and an occupational therapist conducted the on-road driving test. A physician and an experienced consultant in clinical neuropsychology executed the conclusion (pass/fail). The results were reported to country authorities for final decisions.

2.2 Assessment

2.2.1 Neuropsychological measures

The following neuropsychological test battery was administered in one or more sessions (See Lezak, 2004 and Sundet et al., 1995 for detailed description of the test battery used), including measures of *Visual attention/reaction time:* Tachistoscope, React (Gianutsos). *Sensomotoric tempo/coordination*: Grooved Pegboard. *Attention/psychomotor tempo:* Trail Making Test part A (TMT A, Halstead Reitan), Serial Digit Modalities Test (SDMT, oral and written version), Stroop Color-Word Interference 1 & 2 (D-KEFS), Digit span (WAIS III), *Executive functions:* Trail Making Test part B (TMT B, Halstead-Reitan), Stroop Color-Word Interference 3 & 4 (D-KEFS). *General intellectual capacity*: Similarities, Block design (Wechsler Adult Intelligence Scale III, WAIS III).

2.2.2 Measures of Self-Awareness and Executive function

The Awareness Questionnaire (AQ) (Sherer, Bergloff, Boake et al., 1998, Norwegian translation by Løvstad, Solbakk, Schanke & Schanke, 2007) includes 17 items where the patients' rate their *current* functional abilities in comparison to their abilities *pre-injury*. The items are rated on a Likert scale ranging from one (much worse) to five (much better), and scores can range from 17 to 85, where a score of 51 implies that the patient is rating his or her function level as 'about the same' as his or her function level pre-injury. The subtraction of the family ratings from patient self-ratings provides a calculated measure of impaired self-awareness. The discrepancy scores can range from -68 to 68. Higher discrepancy scores indicate greater degrees of impaired self-awareness. AQ includes three subscales found through factor analysis: Motor/Sensory (SM, including four items), Cognition (Cog, including seven items) and Behavioural/Affective (BA, including six items). Reliability studies have demonstrated internal consistency-based measures (Cronbach's alpha) of 0.88 for both patient and family ratings, and studies have confirmed that TBI patients tend to rate themselves as better functioning than their families or clinician rates them (Sherer, Boake et al., 1998). Although the Awareness Questionnaire was originally developed for measuring impaired self-awareness after TBI, it has been shown to be reliable and valid for use in other populations such as stroke (Sherer, Bergloff, Levin, et al., 1998). *Examples of items:* Patient-form ‘3. How well do you get along with people now as compared to before your injury?’ (example from the corresponding relative form: ‘3. How well does the patient get along with people now as compared to before his/her injury?’),‘4. How well can you do on tests that measure thinking and memory skills now as compared to before your injury?’, ‘9. How good is your coordination now as compared to before your injury?’ (see Appendix 1.1. for patient form and Appendix 1.2. for relative form).

The Behaviour Rating Inventory of Executive Function, adult version (BRIEF-A, 18-90 years) (Roth, Isquith & Gioia, 2005, Norwegian translation by Nicholas & Solbakk, 2006) state 75 behaviours to be rated as *never, sometimes* or *often* being a problem over the past four weeks. Nine scales corresponding to domains of executive function are included. Sores on the scales result in two broad indexes: Behavioral Regulation Index (BRI, including the scales inhibit, shift, emotional control and self-monitoring) and Metacognition Index (MI, including the scales initiate, working memory, plan-organize, task monitor and organisation of materials), and an overall summary score, Global Executive composite (GEC). Three validity scales are included (Negativity, Inconsistency, and Infrequency). The normative sample includes 1,136 adults from a wide range of racial/ethnic backgrounds, geographic regions and educational backgrounds. Profiles for diagnostic groups are presented in the manual. Studies have demonstrated internal consistency-based measures (Cronbach’s alpha) of 0.93-0.96 on indexes and overall score, and 0.73-0.90 on clinical scales. *Examples of items:* ‘8. I have trouble changing from one activity or task to another’, ‘42. I get emotionally upset easily’, ‘70. I don’t think about consequences before doing something’, ‘73. I am impulsive’ (patient and relative forms are not included in Appendices due to copyright).

2.3 Statistical Analyzes

Statistical analyses were made using SPSS (Statistical Package for the Social Sciences) version 20.0. The analyses preferably used were Person product moment correlations, *t*-test for dependent and independent samples, corresponding non-parametric tests, cross-tabulation analyses and ANOVA. The analyses are featured in relation to the tables.

3 Results

3.1 Awareness Questionnaire and BRIEF-A

3.1.1 Descriptive statistics of the Awareness Questionnaire

Table 3. *Mean and standard deviation of the Awareness Questionnaire (AQ)*

	N	Min	Max	Mean	*SD*	*t*-value[1)]
Patients' scores						
Total	87	29	58	46,3	5,7	-7,75***
MS	87	5	13	10,8	1,5	-7,47***
COG	87	9	23	18,9	2,8	-7,10***
BA	87	8	24	16,5	2,6	-5,25***
Relatives' scores						
Total	69	26	74	45,6	7,1	-6,35***
MS	69	6	13	10,5	1,7	-7,77***
COG	69	10	33	18,8	3,5	-5,24***
BA	69	9	28	16,3	2,9	-4,78***
Discrepancy scores						*t*-value[2)]
Total	69	-19	23	-0,9	6,6	1,11
MS	69	-5	4	-0,3	1,4	1,92
COG	69	-10	11	-0,3	3,2	0,65
BA	69	-7	10	-0,3	2,9	0,86

[1)] Difference from score on scales natural midpoint (Total=51, MS=12, COG=21, and BA=18), One-sample t-test
[2)] T-test for dependent samples
* *p* <.05, ***p*<.01, ****p*<.001
Note. MS: Motor/Sensory, Cog: Cognition, BA: Behavioral/Affective

Apparent in Table 3, the patients reported themselves as a little worse than pre-injury as apparent in the significant differences between mean patient scores and the Awareness Questionnaire scales' natural mid-point value (Table 3)[1]. However, the range in scores shows that some patients report themselves as much worse, and some even better than pre-injury. The relatives' ratings are fairly similar to the patients' ratings, and the average discrepancy scores consequently relatively low with no significant differences. However, the distribution

[1] The scales natural mid-point represents an average score of 3 on all items, hence no difference in functioning after injury as compared to before.

does include some cases with high discrepancy scores, illustrated in Figure 1 (see Appendix 2.1. for distribution of subscales).

3.1.2 Descriptive statistics of BRIEF-A

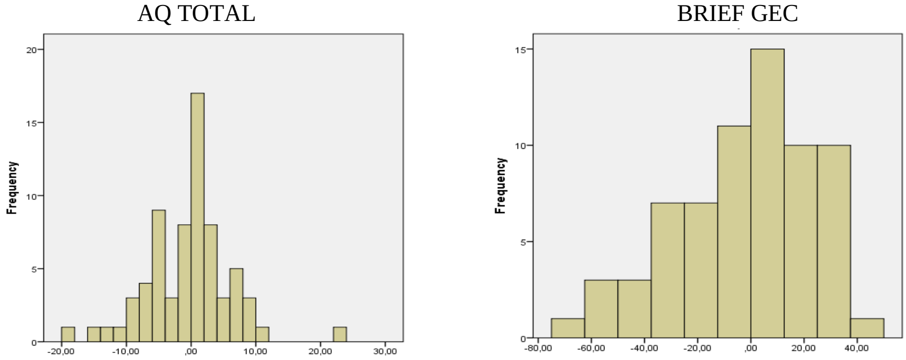
Table 4. *Mean and standard deviation of BRIEF-A*

	N	Min	Max	Mean	*SD*	
Patients' scores						
BR	84	36	73	46,9	9,1	
MT	84	36	70	47,5	9,1	
GEC	84	35	68	47,0	9,2	
Relatives' scores						
BR	68	37	72	47,7	8,9	
MC	68	36	79	50,0	11,0	
GEC	68	35	73	48,9	9,9	
Discrepancy scores						*t*-value[1)]
BR	68	-34	20	-1,0	11,7	-0,58
MC	68	-52	28	-2,6	17,4	-1,79
GEC	68	-68	48	-2,9	26,0	-1,33

[1)] *t*-test for dependent samples
Note. BR: Behavior regulation Index, MI: Metacognition Index, GEC: Global Executive Composite

Apparent in Table 4, the average scores on the Behavioral rating inventory of executive function-adult (BRIEF-A) were well below clinical cut off, defined as a T score of 65 or greater according to the BRIEF-A manual. This accounted for both patients' and relatives' ratings. The differences between patients' and relatives' scores were not statistically significant. However, the distribution includes some cases of high discrepancy scores, illustrated in Figure 1 (see Appendix 2.2. for distribution of index scores).

Figure 1. Distribution of AQ Total and BRIEF-A Global Executive Composite (GEC) discrepancy scores.



3.1.3 The interrelationship between Awareness Questionnaire and BRIEF-A

Pearson product-moment correlation was used to examine the interrelationship between the Awareness Questionnaire and BRIEF-A.

Table 5. *The interrelationship between the Awareness Questionnaire (AQ) and BRIEF-A*

N = 84 for Patients' scores, 68 for Relatives'/Discrepancy scores

BRIEF / *AQ*	P BRI	P MI	P GEC	R BRI	R MI	R GEC	Dis BRI	Dis MI	Dis GEC
P Total	-,295 **	-,423 **	-,388 **	-,331 **	-,318 **	-,344 **	,115	,077	,111
P MS	-,020	-,119	-,080	-,180	-,164	-,177	,096	,035	,088
P COG	-,301 **	-,427 **	-,393 **	-,287 *	-,314 **	-,325 **	,085	,083	,093
P BA	-,317 **	-,408 **	-,388 **	-,337 **	-,293 *	-,332 **	,111	,067	,099
R Total	-,066	-,094	-,084	-,585 **	-,561 **	-,629 **	,490 **	,494 **	,518 **
R MS	-,065	-,084	-,079	-,446 **	-,475 **	-,508 **	,366 **	,424 **	,442 **
R COG	-,053	-,104	-,084	-,493 **	-,478 **	-,535 **	,408 **	,399 **	,421 **
R BA	-,061	-,056	-,059	-,582 **	-,524 **	-,603 **	,497 **	,487 **	,509 **
Dis Total	,151	,216	,200	-,352 **	-,336 **	-,388 **	,433 **	,471 **	,468 **
Dis MS	,020	,121	,083	-,316 **	-,366 **	-,391 **	,316 **	,449 **	,411 **
Dis Cog	,142	,176	,172	-,325 **	-,287 *	-,342 **	,392 **	,384 **	,401 **
Dis BA	,179	,239 *	,225	-,289 *	-,269 *	-,314 **	,399 **	,427 **	,422 **

** Correlations is significant at the 0,01 level (2-tailed)
* Correlations is significant at the 0,05 level (2-tailed)
Note. AQ: MS: Motor/Sensory, Cog: Cognition, BA: Behavioral/Affective
BRIEF: BRI: Behavior regulation Index, MI: Metacognition Index, GEC: Global Executive Composite
P: Patients' scores, R: Relatives' scores, Dis: Discrepancy scores

Moderate to low correlations were found between the Awareness Questionnaire (AQ) and BRIEF-A, with the strongest correlations between the relatives' scores on the two questionnaires, as shown in Table 5. While the correlations on the patients' scores on the two questionnaires were weak and non-significant, the relationship between the discrepancy scores showed moderate significant correlations.

3.1.4 Patients’ and relatives’ ratings on Awareness Questionnaire and BRIEF-A

The relationship between patients’ and relatives’ ratings on the Awareness Questionnaire (AQ) and BRIEF-A, respectively, were examined using Person product-moment correlation.

Table 6. *The relationship between patients’ and relatives’ ratings on Awareness Questionnaire (AQ).*

N = 69

Relatives / *Patients*	Total	MS	Cog	BA
Total	,487**			
MS	,277*	,605**		
Cog	,478**	,224	,497**	
BA	,433**	,268*	,394**	,430**

**$p < .01$

* $p <.05$

Note. MS: Motor/Sensory, Cog: Cognition, BA: Behavioral/Affective

Table 7. *The relationship between patients’ and relatives’ ratings on BRIEF-A.*

n = 67

Relatives / *Patients*	BRI	MI	GEC
BRI	,255*		
MI	,130	,274*	
GEC	,192	,220	,221

**$p < .01$

* $p <.05$

Note. BRI: Behavior regulation Index, MI: Metacognition Index, GEC: Global Executive Composite

As apparent from Table 6 and 7, moderate to strong correlations were found between the patients’ and relatives’ scores on the equivalent AQ subscales. Consistently lower correlations were found between the patients’ and relatives’ scores on BRIEF-A, indicating differences in rating on the two questionnaires.

3.2 The relationship between AQ/BRIEF-A and neuropsychological tests

3.2.1 Awareness Questionnaire and neuropsychological tests

Pearson product moment correlations were used to examine the relationship between the Awareness Questionnaire and the neuropsychological tests.

Table 8. *The relationship between Awareness Questionnaire (AQ) and neuropsychological tests*

N (61-89)

AQ	*Patients' scores*				*Relatives' scores*				*Discrepancy scores*			
Neuropsychological tests:	Total	MS	Cog	BA	Total	MS	Cog	BA	Total	MS	Cog	BA
Visual Attention/Reaction time												
Tachistoscope Simple												
Total	,124	,166	,082	,092	,122	,274 *	,044	,090	,003	,081	-,034	,004
Left	,179	,277 **	,102	,127	,154	,304 *	,046	,147	,001	,037	-,048	,036
Middle	,135	,054	,133	,125	-,044	,062	-,059	-,072	-,093	-,011	-,097	-,100
Right	-,126	-,107	-,101	-,108	,156	,205	,153	,080	,156	,250 *	,147	,070
False positives	,086	,051	,110	,044	,025	-,033	,043	,028	,018	,029	-,027	,055
Tachistoscope Complex												
Total	,083	,080	,055	,079	,210	,254 *	,172	,162	,120	,109	,126	,082
Left	,111	,117	,085	,087	,268 *	,308 **	,190	,249 *	,198	,145	,154	,210
Middle	-,025	-,003	-,068	,020	-,172	-,126	-,139	-,182	-,181	-,152	-,109	-,216
Right	,042	,032	,030	,043	,195	,210	,191	,127	,119	,129	,148	,045
False positives	,202	,249 *	,094	,203	,193	,272 *	,129	,162	,007	,025	,042	-,040
React												
Left	-,127	,002	-,137	-,135	-,083	,038	-,032	-,185	-,064	,048	-,007	-,160
Middle	-,104	,046	-,148	-,099	-,218	-,077	-,197	-,253 *	-,189	-,181	-,123	-,203
Right	-,099	-,039	-,096	-,093	-,283 *	-,268 *	-,207	-,290 *	-,237	-,205	-,177	-,244 *
Sensomotoric												
Grooved Pegboard DH	,112	,354 **	,033	,026	,282 *	,367 **	,192	,249 *	,125	,056	,085	,160
Grooved Pegboard NDH	,124	,489 **	-,013	,027	,176	,357 **	,090	,136	,032	-,160	,038	,102
Attention/psychomotor tempo												
TMT A	,237 *	,219 *	,249 *	,132	,188	,153	,178	,157	-,010	-,123	-,027	,066
SDMT Oral	,131	,188	,166	,004	,140	,181	,124	,088	,015	-,027	-,038	,087
SDMT Written	,110	,136	,140	,018	,122	,215	,105	,050	,049	,114	-,010	,066
Stroop 1	,043	,046	,126	-,066	,075	,053	,097	,037	-,012	-,042	-,049	,045
Stroop 2	,204	,139	,266 *	,090	,245 *	,155	,269 *	,189	,058	-,012	,049	,083
Digit span	-,130	-,139	-,035	-,171	-,060	-,093	-,021	-,069	,083	,065	,041	,111
Executive function												
TMT B	,197	,157	,246 *	,083	,179	,184	,170	,127	,045	,000	-,013	,116
Stroop 3	,076	-,012	,141	,027	,061	-,052	,114	,040	,016	-,065	,016	,052
Stroop 4	,116	-,003	,204	,042	,065	-,068	,111	,062	-,014	-,078	-,045	,054
General intellectual capasity												
Block design	,007	,108	,012	-,058	-,053	-,028	-,034	-,071	-,096	-,142	-,112	-,025
Similarities	-,102	-,182	-,040	-,078	-,016	-,163	,025	,024	,026	,069	-,013	,039

** Correlations is significant at the 0,01 level (2-tailed)

* Correlations is significant at the 0,05 level (2-tailed)

Note. DH: Dominant hand, NDH: Non-dominant hand, TMT: Trail Making Test, SDMT: Serial Digit Modalities Test.
MS: Motor/sensory, Cog: Cognition, BA: Bahavioral/Affective. Reversed scale on React

As apparent in Table 8, the strongest correlations were found between Grooved Pegboard and both patients and relatives’ ratings on the Motor/Sensory (MS) subscale. Patients rating themselves as ‘about the same’ as pre-injury performed better on the measure of sensomotoric coordination than the patients’ rating themselves as worse than pre-injury. In general, weak and non-significant correlations were found on all other tests. The significant correlations showed that low ratings on the Awareness Questionnaire were related to poor performance on various tests. A predominance of correlations were found between the MS subscale on Awareness Questionnaire and various cognitive tests, indicating a relationship between this subscale and some of the cognitive tests applied in the fitness-to-drive assessments. The relatives’ ratings correlated somewhat stronger with the various tests than the patient’s ratings, indicating more accurate evaluation of the patients’ function. The correlations between the neuropsychological tests and the discrepancy scores were non-significant, with the exception of a weak correlation between Tachistoscope Simple right and the discrepancy score on the MS subscale, and a weak correlation between React right and the discrepancy scores on the BA subscale. No significant correlations were found between ratings on the Awareness Questionnaire and measures of IQ.

3.2.2 BRIEF-A and neuropsychological tests

Pearson product moment correlations were used to examine the interrelationship between BRIEF-A and neuropsychological tests.

Table 9. *The relationship between BRIEF-A and neuropsychological tests*

N (65-84)

BRIEF-A	***Patients' scores***			***Relatives' scores***			***Discrepancy scores***		
Neuropsychological tests:	BRI	MI	GEC	BRI	MI	GEC	BRI	MI	GEC
Visual Attention/Reaction time									
Tachistoscope Simple									
Total	-,106	-,121	-,123	-,091	-,096	-,099	,048	,020	,016
Left	-,097	-,146	-,136	-,064	-,100	-,091	,018	,006	-,011
Middle	-,093	-,096	-,102	-,001	,032	,022	-,052	-,092	-,070
Right	-,029	,033	,011	-,207	-,179	-,202	,232	,211	,206
False positives	,086	,066	,084	,032	-,044	-,011	,042	,103	,084
Tachistoscope Complex									
Total	-,058	-,108	-,098	-,062	-,087	-,084	,087	,016	,029
Left	-,033	-,124	-,095	-,097	-,096	-,104	,136	,028	,074
Middle	,014	,046	,031	,184	,222	,223	-,104	-,160	-,119
Right	-,086	-,098	-,102	-,112	-,177	-,163	,071	,086	,040
False positives	-,047	-,086	-,072	**-,276 ***	-,189	**-,241 ***	,207	,106	,154
React									
Left	,118	,034	,073	,027	,045	,038	-,046	-,076	-,030
Middle	,103	-,039	,024	,146	,152	,162	-,158	-,231	-,138
Right	,138	,063	,097	,154	,224	,211	-,145	-,205	-,148
Sensomotoric tempo/coordination									
Grooved Pegboard DH	,086	,070	,094	-,052	-,172	-,134	,138	,216	,181
Grooved Pegboard NDH	,028	,077	,066	-,061	-,047	-,051	,148	,140	,155
Attention/psychomotor tempo									
TMT A	-,027	-,023	-,025	,047	-,009	,017	-,002	,013	-,002
SDMT Or	,086	,134	,121	,013	,007	,010	,106	,124	,082
SDMT Wr	,034	,073	,061	,002	-,093	-,060	,103	,204	,135
Stroop 1	,047	-,027	,008	-,020	-,092	-,068	,102	,113	,065
Stroop 2	,050	-,061	-,012	-,111	-,239	-,204	,175	,216	,178
Digit span	-,041	,083	,035	-,003	,149	,101	,041	-,047	-,054
Executive function									
TMT B	-,011	,011	,005	-,009	-,015	-,012	,059	,071	,051
Stroop 3	,058	,036	,047	,008	-,099	-,057	,137	,164	,110
Stroop 4	,038	-,011	,008	,033	-,033	-,003	,086	,065	,033
General intellectual capasity									
Block design	-,042	-,015	-,031	,135	,130	,145	-,130	-,131	-,164
Similarities	-,072	,029	-,015	,011	,065	,046	-,054	-,034	-,059

** Correlations is significant at the 0,01 level (2-tailed)

* Correlations is significant at the 0,05 level (2-tailed)

Note. DH: Dominant hand, NDH: Non-dominant hand, TMT: Trail Making Test, SDMT: Serial Digit Modalities Test. BRI: Behavior Regulation Index, MI: Metacognition Index, GEC: Global Executive Composite. Reversed scale on React

Apparent from Table 9, no significant correlations were found except a positive, weak correlation between Tachistoscope Complex False positives and Relatives' ratings on the Behavioral Regulation index (BRI) and the Global Executive Composite (GEC).

3.3 Group differences: Patients fulfilling criteria for driving and patients *not* fulfilling criteria for driving.

3.3.1 The relationship between neuropsychological tests and outcome

Comparisons of results on neuropsychological tests between the group of patients that fulfilled the criteria for driving and the group of patients that did *not* fulfill the criteria for driving were made using independent samples *t*-tests.

Table 10. *Mean difference on neuropsychological tests between the group of patients fulfilling criteria for driving and the group of patients not fulfilling the criteria for driving.*

	Fulfilled criteria for driving						
	No			**Yes**			
Neuropsychological tests	*n*	Mean	*SD*	*n*	Mean	*SD*	*p*
Visual Attention/Reaction time							
Tachistoscope Simple							
Total	42	49,1	5,6	46	53,3	1,9	0,00 **
Left	42	20,7	4,0	46	22,8	1,1	0,00 **
Middle	42	6,5	2,0	46	7,6	1,1	0,00 **
Right	42	22,0	2,2	46	23,0	0,1	0,00 **
False positives	42	0,1	0,4	46	0,0	0,0	0,10
Tachistoscope Complex							
Total	42	34,2	9,1	46	41,7	5,7	0,00 **
Left	43	14,3	5,1	46	18,0	3,3	0,00 **
Middle	43	5,2	2,2	46	5,5	2,2	0,45
Right	43	15,0	5,3	46	18,2	3,2	0,00 **
False positives	42	3,0	4,1	46	1,3	1,8	0,02 *
React							
Left	42	0,4	0,2	45	0,3	0,1	0,07
Middle	42	0,3	0,1	45	0,3	0,1	0,12
Right	42	0,4	0,1	45	0,3	0,0	0,01 **
Sensomotoric tempo/coordination							
Grooved Pegboard DH	40	38,6	11,3	45	47,8	12,8	0,00 **
Grooved Pegboard NDH	36	37,4	9,2	38	45,7	11,0	0,00 **
Attention/psychomotor tempo							
TMT A	42	37,9	9,5	45	49,5	9,4	0,00 **
SDMT Oral	43	30,9	12,1	46	44,8	10,5	0,00 **
SDMT Written	41	30,0	10,7	45	43,3	10,4	0,00 **
Stroop 1	43	6,3	3,5	44	8,1	3,4	0,02 *
Stroop 2	43	7,3	3,8	44	9,1	2,9	0,01 **
Digit Span	43	8,3	2,5	45	9,7	2,8	0,01 **
Executive Function							
TMT B	42	35,3	10,5	45	49,7	9,6	0,00 **
Stroop 3	43	6,5	4,0	44	10,0	2,9	0,00 **
Stroop 4	42	5,9	4,2	44	9,0	3,7	0,00 **
General intellectual capasity							
Block design	42	8,2	2,3	45	11,1	3,0	0,00 **
Similarities	43	9,2	3,6	44	9,4	3,1	0,78

* *p* <.05, ***p* < .01

Note. DH: Dominant hand, NDH: Non-dominant hand, TMT: Trail Making Test, SDMT: Serial Digit Modalities Test.

The group that fulfilled the criteria for driving performed significantly better on all of the neuropsychological tests with the exception of two Tachistoscope subtests, React left and middle, and similarities, illustrated in Table 10. Non-parametric test conducted on Tachistoscope and React due to skewedness, showed corresponding results with the exception of lack of significant difference on Tach com FP, and React left showing a significant difference within the two groups.

3.3.2 The relationship between Awareness Questionnaire/ BRIEF-A and outcome

Independent samples *t*-tests were used to compare the results on the Awareness Questionnaire (AQ) and BRIEF-A between the group of patients that fulfilled the criteria for driving and the group of patients that did *not* fulfill the criteria for driving

Table 11. *Mean difference on AQ and BRIEF-A between the group of patients that fulfilled the criteria for driving and the group of patients that did not fulfill the criteria for driving.*

	Fulfilled criteria for driving						
	No			**Yes**			
AQ	*n*	Mean	*SD*	*n*	Mean	*SD*	*p*
Patients' scores							
Total	41	45,3	5,6	46	47,2	5,7	0,12
MS	41	10,6	1,6	46	11,0	1,3	0,19
Cog	41	18,4	2,9	46	19,3	2,6	0,13
BA	41	16,2	2,3	46	16,8	2,8	0,28
Relatives' scores							
Total	29	44,9	8,1	40	46,1	6,4	0,50
MS	29	10,2	1,6	40	10,7	1,7	0,24
Cog	29	18,6	4,0	40	18,9	3,1	0,70
BA	29	16,1	3,1	40	16,5	2,8	0,61
Discrepancy scores							
Total	29	-0,7	8,2	40	-1,1	5,2	0,81
MS	29	-0,3	1,7	40	-0,4	1,2	0,78
Cog	29	0,0	3,9	40	-0,5	2,5	0,56
BA	29	-0,4	3,3	40	-0,2	2,7	0,79
BRIEF-A							
Patients' scores							
BRI	39	46,3	8,8	45	47,4	9,5	0,59
MI	39	47,1	8,5	45	47,8	9,7	0,72
GEC	39	46,5	8,5	45	47,5	9,8	0,63
Relatives' scores							
BRI	28	47,1	8,0	40	48,1	9,5	0,68
MI	28	52,0	12,3	40	48,6	10,0	0,21
GEC	28	49,8	10,3	40	48,2	9,7	0,54
Discrepancy scores							
BRI	28	-1,6	11,4	40	-0,6	12,1	0,72
MI	28	-7,3	19,2	40	0,7	15,5	0,06
GEC	28	-7,1	25,3	40	0,2	26,4	0,26

Note. AQ: MS: Motor/Sensory, Cog: Cognition, BA: Behavioral/Affective
BRIEF-A: BRI: Behavior Regulation Index, MI: Metacognition Index, GEC: Global Executive Composite

As apparent in Table 11, no significant differences were found between the group of patients that fulfilled the criteria for driving, and the group of patients that did not fulfill the criteria for driving in terms of how the patients reported themselves, how the relatives rated them and the discrepancy scores on the two questionnaires. Adjustment for age differences when comparing the two groups was not found necessary, as neither scores on Awareness Questionnaire or BRIEF-A were significantly related to the respondents' age.

As shown in section 3.1, the discrepancy scores contained both positive and negative values. Positive discrepancy scores are of less interest, as the current study concern fitness-to-drive assessments. As including positive scores in the analysis might bias the results when comparing the two groups, two additional analyses were done to examine the impact of negative discrepancy scores on the decision to clear the patients for driving or not.

First, all positive discrepancy scores were re-coded to the value zero, while the negative discrepancy scores were kept as their original scores. Both parametric (*t*-test for independent samples) and non-parametric (Mann-Whitney U-test) were applied when comparing the two groups. The analysis showed no significant differences between the group of patients that fulfilled the criteria for driving, and the group of patients that did *not* fulfill criteria for driving (see Appendix 3.1. for AQ and Appendix 3.2. for BRIEF-A).

Second, the sample was split into two groups based on their discrepancy scores; all patients having the score -6 (i.e. one SD below the mean value) or less as their total AQ-discrepancy score were categorized as a 'high discrepancy' group, whereas all other values were categorized into 'low discrepancy' group.

Table 12. *The relationship between AQ discrepancy groups and outcome.*

Crosstabulation

		Fulfilled criteria for driving		
Group		**No**	**Yes**	Total
High discrepancy	*n*	9	9	18
	% within group	50 %	50 %	100 %
Low discrepancy	*n*	31	20	51
	% within group	60,80 %	39,20 %	100 %
Total	*n*	40	29	69
	% within group	58 %	42 %	100 %

$\chi^2 = 0.635$, p = .427

As shown in Table 12, there were no significant differences between the two groups on the Awareness Questionnaire (AQ) discrepancy scores in terms of fulfilling criteria for driving or not. 50% of the patients in the 'high discrepancy' group fulfilled the criteria for driving. No significant differences were found between the high discrepancy group and the low discrepancy group in terms of demographics, medical data or results on neuropsychological tests.

Equivalent grouping was carried out on BRIEF-A Global Executive Composite discrepancy score, where patients having the score of -28 (i.e. one SD below the mean value) or less on the BRIEF-A were categorized as 'high discrepancy' group, whereas all other values were categorized as 'low discrepancy' group.

Table 13. *The relationship between BRIEF-A discrepancy groups and outcome.*

Crosstabulation

		Fulfilled criteria for driving		
Group		**No**	**Yes**	Total
High discrepancy	*n*	7	6	13
	% within group	53.8%	46.2%	100 %
Low discrepancy	*n*	21	34	55
	% within group	38.2%	61.8%	100 %
Total	*n*	28	40	68
	% within group	41.2%	58.8%	100 %

$\chi^2 = 1.07$, $p = .302$

Apparent from Table 13, there were no significant differences between the two groups on BRIEF-A discrepancy scores in terms of fulfilling criteria for driving. 46, 2% of the patients in the 'high discrepancy' group fulfilled the criteria for driving. No significant differences were found between the high discrepancy group and the low discrepancy group in terms of demographics, medical data or results on neuropsychological tests.

3.4 Localization of injury

3.4.1 The relationship between Localization of injury and outcome

Differences in localization of injury between the group of patients that fulfilled the criteria for driving and the group of patients that did *not* fulfill the criteria for driving were examined using cross-tabulation and Pearson Chi-Square. The patients with cerebellum pons injury were excluded of the analyses due to low sample size (N=5).

Table 14. *The relationship between localization of injury and outcome*

		Fulfilled criteria for driving		
Localization:		**No**	**Yes**	Total
Left	*n*	12	16	28
	% within group	42,9 %	57,1 %	100 %
Right	*n*	19	10	29
	% within group	65,5 %	34,5 %	100 %
Multifocal	*n*	12	13	25
	% within group	48,0 %	52,0 %	100 %
Total	*n*	43	39	82
	% within group	52,4 %	47,6 %	100 %

$\chi^2 = 3.22$, $p = .20$

Note. Missing data on localization of injury: 2 (2,2%)

As shown in Table 14, no significant differences were found between the groups. However, there was a tendency for patients with right hemisphere injury to *not* fulfill the criteria for driving.

3.4.2 The relationship between Localization of injury and AQ/BRIEF-A

One-way ANOVA was used to investigate the relationship between localization of injury and scores on the two questionnaires. With one exemption of both patients' and relatives' scores on the Motor/Sensory subscale on Awareness Questionnaire, no significant group differences in either mean scores or mean discrepancy scores were found. Post Hoc tests with Bonferroni correction showed that the group of patients with left hemisphere injury reported significantly better sensory-motor function than the other groups, as did their relatives. However, the difference on the relatives' scores was non-significant when Bonferroni correction was applied (see Appendix 4.1.). Equivalent analyses were conducted on BRIEF-A, showing no significant differences in either mean scores or discrepancy scores between the groups (see Appendix 4.2.).

4 Discussion

The purpose of the present study was to explore the additional value of measuring self-awareness in cognitive assessments for holding a drivers' license among TBI and stroke patients. To the author's knowledge, no previous studies has included BRIEF-A as a measure of self-awareness of executive function in relation to fitness-to-drive assessments. A few studies have included the Awareness Questionnaire when investigating the relevance of self-awareness in driving (Griffen et al., 2011; Scott, 2010). However, various requirements for fulfilling criteria for safe driving make comparisons difficult.

The first objective of the study was to examine whether BRIEF-A can be used as a measure of self-awareness of executive function. Hypothesis 1 was confirmed, as the discrepancy scores on BRIEF-A showed moderate correlations with the discrepancy scores on the Awareness Questionnaire, indicating that BRIEF-A discrepancy scores may be a valid measure of self-awareness of executive function. However, while a substantial level of agreement was found between the patients' self-rating and their relatives' ratings on the Awareness Questionnaire, the relationship between the patients' self-ratings and their relatives' ratings were consistently weaker on BRIEF-A, indicating differences in rating on the two questionnaires of uncertain cause. The differences in ratings may be derived from scale qualities, especially as relatives' rating of function post-injury compared to pre-injury on the Awareness Questionnaire probably require less comprehensive observation than reporting *how often* patients' experience difficulties related to impairments on BRIEF-A. Furthermore, although the patients reported less impairment than their relatives, the mean discrepancy scores on both questionnaires show that on average, the relatives' ratings did not differ significantly from the patients' self-ratings. Interestingly, both patients and relatives reported on average low levels of difficulty on both questionnaires. Although the questionnaires were not included in the decisions for or against holding a drivers' license, this may reflect social desirability effects as the associated context of fitness-to-drive assessments presumably influence both the patients' reporting and relatives' ratings in terms of underreporting. On the other hand, the results might indicate low average level of impaired self-awareness in the current sample. Finally, the assumption that Awareness questionnaire possesses high validity is questionable considering the range of methodological issues associated with the use of patients and relatives comparisons as method, discussed in section

4.1. However, the results indicate that BRIEF-A may function as a measure of self-awareness of executive function. As higher order cognitive abilities are critical for safe driving (Lundquist & Alinder, 2007), having an adequate awareness of executive limitations is essential for the ability to develop compensatory strategies at tactical and strategic levels of driving performance (Lundberg et al., 2003). In this respect, self-awareness of executive function is a highly relevant aspect that should be of consideration in fitness-to-drive assessments. However, more research is needed to validate the specificity of BRIEF-A as a measure of executive function (Løvstad et al., in press), in addition to investigating whether it can provide a valid measure of impaired awareness of executive functions.

The second objective of the study was to investigate the potential additional value of the questionnaires, i.e. whether the Awareness Questionnaire and BRIEF-A measure other factors than the neuropsychological tests do. The relationships found between the Awareness Questionnaire and neuropsychological tests showed a predominance of significant correlations on the Motor/Sensory (MS)-subscale, indicating that this scale might be more closely related to performance on neuropsychological tests compared to the other subscales. Hypothesis 2.1 was confirmed, as the strongest correlations were found between the Motor/Sensory (MS) subscale and performance on a sensory-motoric coordination test. This indicates dissociation between different components of self-awareness, i.e. patients exhibiting more accurate self-awareness of sensory motor function than of higher order cognitive functioning in accordance with previous research (Prigatano, 1996). In terms of driving, this implies that safe driving performance at the operational level, which is related to motor-sensory function, is more likely than safe driving performance at the tactical and strategic level after brain injury. BRIEF-A showed no significant correlations with neuropsychological tests with the exception of one subtest of visual attention, supporting hypothesis 2.2. and the general assumption that BRIEF-A might tap onto other aspects of executive function than the neuropsychological tests do (Anderson et al., 2002; McAuley et al., 2010; Løvstad et al., in press). However, as correlations have been found between BRIEF-A and SCL-90-R (Løvstad et al., in press), more research is needed to establish whether BRIEF-A are specific to executive functions, or if it, to some degree, also reflects general psychological distress which may cause temporary executive dysfunction.

The third objective of the study was to investigate whether the measures of self-awareness were related to outcome (patients fulfilling the criteria for driving or not), i.e. if the measures could predict the outcome in the conclusions for or against holding a drivers' license in the current sample. No significant differences were found between the patients that fulfilled the criteria for driving and the patients that did *not* fulfill the criteria for driving in terms of self-awareness, indicating that the questionnaires may be valuable as supplements in fitness-to-drive assessments. Thus, hypothesis 3, assuming that measures of self-awareness could not predict the outcome, was confirmed. Further analysis revealed that nine patients scoring more than one SD below the mean value on the Awareness Questionnaire discrepancy scores fulfilled the criteria for driving, and that six patients that fulfilled the criteria for driving showed high discrepancy scores on BRIEF-A. Considering how awareness of one's cognitive function is a prerequisite for safe driving (Lundquist & Alinder, 2007; Tamietto et al., 2006), these patients might potentially represent a danger in traffic.

The final objective of the study was to examine the relationship between location of injury (left, right or multifocal) and both outcome (fulfilling the criteria for driving or not) and self-awareness. Localization of injury was related to neither outcome nor self-awareness. Thus, hypothesis 4 was not confirmed, supporting research suggesting that damages in neural networks including multiple localizations in the brain rather than focal areas may be related to impaired self-awareness (Sherer et al., 2005).

In summary, the results indicates that both BRIEF-A and the Awareness Questionnaire may serve as valuable supplements in fitness-to-drive assessments, as they seem to measure aspects of higher order cognitive functioning not covered by neuropsychological tests. Driving at the tactical and strategic level relies on both executive function and self-awareness, thus, methods measuring these aspects should be included in fitness-to-drive assessments. Furthermore, the results revealed that some patients with impaired self-awareness fulfilled the criteria for driving. Although the low-discrepancy group outnumbered the high-discrepancy group in terms of fulfilling the criteria, emphasize should be given to the patients with impaired self-awareness who fulfilled the criteria for driving, as the ability to adjust driving behavior depends on self-awareness of one's own cognitive function (Lundquist & Alinder, 2007). However, as the Awareness Questionnaire and BRIEF-A measure patients' ability to recognize the *existence* of deficits, and not the ability to acknowledge difficulties due to cognitive impairment as they arise, nor strategic adjustment of behaviour (Fleming et al., 1996), it is unknown whether the patients who exhibited adequate self-awareness in the current sample may fail to make use of this knowledge when driving on the tactical and strategic level. Thus, methods measuring all aspects of self-awareness are needed.

4.1 Limitations and methodological issues

The patients participating in the study possessed distinct characteristics, thus, the sample is not representative. Consequently, the findings cannot be generalized with certainty. The small proportion of relatives' ratings on the questionnaires reduces the sample size in analysis including relatives' ratings and discrepancy scores. Furthermore, the sample size limits the statistical examination of the impact of localization due to the four small groups containing various numbers of subjects. The localization of brain injury were roughly categorized (right, left, multifocal and cerebellum pons), lacking accurate information about extent of injury, brain structures involved and diffuse axonal injury. Additionally, the present study does not take the differentiation between neurological and psychological factors involved in self-awareness into account, which limits the knowledge about what the discrepancy scores imply, i.e., if the scores reflect impaired self-awareness attributable to neurologic injury, denial or a combination of both.

The value of Awareness Questionnaire and BRIEF-A as measures of self-awareness are generally restricted, as they measure intellectual awareness only. Considering the possible dissociation between intellectual awareness, i.e. recognizing the level of functioning, and emergent- and anticipatory awareness, i.e. *the use* of this awareness to monitor online performance and make strategic decisions (Toglia & Kirk, 2000), one cannot assume that these questionnaires provide information about impaired self-awareness on several levels. Although impaired intellectual awareness is of profound importance for safe driving, the development of measures including emergent and anticipatory awareness is needed.

The application of the models of self-awareness proposed by Crosson et al. (1989) and Toglia and Kirk (2000) can be questioned, as the models were not specifically developed in relation to safe driving performance, but focus on the impact of self-awareness on daily life functioning and rehabilitation. The uncertainty regarding the translational value applies for the questionnaires as well, as they do not measure self-awareness of *driving performance*. However, previous research have shown significant relationships between impaired self-awareness measured by the Awareness Questionnaire and on-road driving performance

(Griffen et al., 2011) and performance in driving simulators (Scott, 2010). The patients in the current sample lacked knowledge of their own driving skills post-injury at the time of the fitness-to-drive assessments, as these decisions are required before the patients are allowed to resume driving. Thus, fitness-to-drive assessments including self-awareness of post-injury driving performance are difficult to conduct without a driving simulator.

Although discrepancy ratings are the most commonly used measure of self-awareness, substantial methodological issues associated with this method are in need for consideration. In general, self-report questionnaires are reported as vulnerable to misreading of items and variable interpretations (McCrae, Stone, Fagan & Costa, 1998), which poses a threat to the validity of quantified scores (Fleming et al., 1996). As with self-reporting, relatives' ratings are prone to biases and validity threats. The use of such ratings is based on the assumption that information from relatives provides an objective evaluation, or a valid "reality" of the patients' actual function (Bach & David, 2006). However, the relatives' experience of the patient is highly subjective, and a number of factors might influence the rating (Fleming et al, 1996). There is some evidence that relatives adopt a less severe standard for rating impairment than clinicians, and some argue that clinician ratings is a more valid measure of impaired self-awareness (Sherer et al., 2003). However, clinicians' ratings may be biased by other factors such as likeability (Malec, Machulda & Moessner, 1997), and their observation of the patients is limited. Furthermore, the use of the calculated discrepancy scores requires carefully interpretation as analyses on group level might contain scores of opposite directions confusing the mean values. The incidence of cases where patients report higher degree of impairment than their relatives do might be derived from various factors. Pre-morbid personality might influence patients' self-perception and self-reporting, the relatives' observation of the patient might be insufficient, or relatives' motivation might bias the ratings.

Importantly, the *context* of fitness-to-drive assessments make self-reporting and relatives' ratings particularly vulnerable to social desirability effects and underreporting. Although the participants were explicitly told that the questionnaires were *not* part of the basis for the decisions, the completion of the questionnaires in relation to fitness-to-drive assessments were likely to affect the responses. Additionally, the context might affect relatives' responses depending on the relationship with the patient, perceived earnest and the possible loss of driver benefits if they do not possess a drivers' license themselves.

Furthermore, the assumed combination of respectively both psychological and biological factors that may underlie- and influence self-reporting of own difficulties (Ownsworth et al., 2002) are difficult to rule out. For example, while some patients *intentionally* report less difficulties than actually present, motivated by the desire to retain his or her driver's license, other patients report less difficulty unconsciously, on the basis of impaired self-awareness or denial.

The lack of empirically based guidelines regarding determination of scaling severity and cut-off values (Clare, Wilson, Carter, Roth, & Hodges, 2004) provide problems considering that the discrepancy scores itself does not provide information about the various combinations of compared ratings resulting in similar discrepancy values. For example, patients characterizing themselves as “about the same” as before injury, while their relatives rate them as “a little worse” will obtain equal discrepancy scores as patients rating themselves as “a little worse” while their relatives rate them as “much worse”. I.e., patients can report both dysfunction and the same level of functioning as pre-injury, and be categorized with impaired self-awareness if their relatives reports higher level of impairment (Cosentino & Stern, 2005).

In summary, rating questionnaires completed by both patients and relatives are widely used as a measure of self-awareness, as this metacognitive phenomenon is not directly captured by neuropsychological tests. However, considering the number of methodological challenges associated with both self-reporting and relative ratings, it remains uncertain whether discrepancy scores can actually provide a valid measure of self-awareness, especially in the context of fitness-to-drive assessments. The use of relative ratings are, however, useful as they provide essential information about patients’ self-perception of impairments compared to their relatives’ perception, and are, as such, essential in cases of impaired self-awareness.

4.2 Implications of the present study

The results of the current study showed that nine and six patients characterized with impaired self-awareness on Awareness Questionnaire and BRIEF-A, respectively, fulfilled the criteria for driving. The present paper illustrates the importance of self-awareness in safe driving performance, and raises an important question concerning the consequences of excluding measures of self-awareness in fitness-to-drive assessments: Do the patients with impaired self-awareness who fulfilled the criteria for driving constitute a danger in traffic?

In relation to implications for research, the overall weak and non-significant correlations between the questionnaires and neuropsychological measures suggest that Awareness Questionnaire and BRIEF-A, respectively, taps onto other aspects related to safe driving performance than the neuropsychological tests included in the study do. However, the specific relevance of these measures of self-awareness in the current context remains unknown.

4.3 Conclusions and future directions

Considering the number of people involved in traffic and the importance of securing safe driving in order to reduce accidents, the decisions following fitness-to-drive assessments do involve public health issues (Tamietto, et al., 2006). Studies demonstrating higher risk of accident involvement after brain injury (Bivona et al., 2012; Formisano et al., 2005; Neyens & Boyle, 2012; Schanke et al., 2008) confirm the importance of precise fitness-to-drive assessments, and the risks involved in the conclusions. As accurate self-awareness of own cognitive function is essential for the ability to adjust driving behavior on the tactical and strategic level (Lundquist & Alinder, 2007), impaired self-awareness should be of considerably high importance in assessments of fitness-to-drive after acquired brain injury. This is supported by the guidelines stating that among other cognitive deficits, impaired self-awareness is considered contrary to safe driving (Norsk Psykologforening, 2012). The patients in the current sample who were characterized with impaired self-awareness, yet fulfilled the criteria for driving, might represent a risk in traffic. However, methodological limitations related to the measurement of self-awareness in addition to the lack of data concerning actual traffic accidents preclude firm conclusions.

The impact of impaired self-awareness on driving performance should be examined in future research in order to increase our understanding of this phenomenon and its related aspects. Furthermore, improving the validity of measures of self-awareness is of profound importance. Finally, research examining the actual consequences of driving with impaired self-awareness is strongly needed, as it may clarify the following essential question: Are patients with impaired self-awareness, who fulfill neuropsychological criteria for driving, more frequently involved in traffic accidents than those with anticipated intact self-awareness? Long-term follow-up accidents studies should be conducted with large groups of subjects who are assessed comprehensively in order to establish more evidence-based guidelines. The contribution of self-awareness as part of the prerequisites in decision-making for holding a drivers` license should be given attention.

References

American Psychiatric Association (1994). *DSM-IV: Diagnostic and statistical manual of mental disorders.* Washington, DC: American Psychiatric Association.

Anderson, V. A., Anderson, P., Northam, E., Jacobs, R., & Mikiewicz, O. (2002). Relationships Between Cognitive and Behavioral Measures of Executive Function in Children With Brain Disease. *Child neuropsychology*, *8*, 231-240. doi: 10.1076/chin.8.4.231.13509

Bach, L. J., & David, A. S. (2006). Self-awareness after acquired and traumatic brain injury. *Neuropsychological rehabilitation*, *16*, 397-414. doi: 10.1080/09602010500412830

Bechara, A., Damasio, H., Damasio, A. R., & Lee, G. P. (1999). Different Contributions of the Human Amygdala and Ventromedial Prefrontal Cortex to Decision-Making. *The Journal of Neuroscience, 19*, 5473-5481. Retrieved from http://www.jneurosci.org/content/19/13/5473.short

Bechara, A., Tranel, D., Damasio, H., Damasio, A. R. (1996). Failure to Respond Autonomically to Anticipated Future Outcomes Following Damage to Prefrontal Cortex. *Cereb. Cortex*, *6*, 215-225. doi: 10.1093/cercor/6.2.215

Bivona, U., Ciurli, P., Barba, C., Onder, G., Azicnuda, E., Silvestro, D.,…Formisano, R. (2008) Executive function and metacognitive self-awareness after severe traumatic brain injury. *Journal of the International Neuropsychological Society*, *14*, 862-868. doi: http://dx.doi.org/10.1017/S1355617708081125

Bivona, U., D'Ippolito, M., Giustini, M., Vignally, P., Longo, E., Taggi, F.,…Formisano, R. (2012). Return to Driving After Severe Traumatic Brain Injury: Increased Risk of Traffic Accidents and Personal Responsibility. *Journal of Head Trauma Rehabilitation, 27*(3), 210-2015. doi: 10.1097/HTR.0b013e31822178a9

Borkowski, J. G. (1996). Metacognition: Theory or chapter heading?, *Learning and Individual Differences, 8,* 391-402. doi: http://dx.doi.org/10.1016/S1041 6080(96)90025-4

Burgess, P. W., Veitch, E., de lacy Costello, A., & Shallice, T. (2000). The cognitive and neuroanatomical correlates of multitasking. *Neuropsychologia, 38,* 848-863. doi: http://dx.doi.org/10.1016/S0028-3932(99)00134-7

Butcher, I., McHugh, G. S., Lu, J., Steyerberg, E. W., Hernandez, A. V., Mushkudiani, N.,…Murray, D. G. (2007). Prognostic value of Cause of Injury in Traumatic Brain Injury: Results from the IMPACT Study. *Journal of Neurotrauma, 24*, 281-286. doi:10.1089/neu.2006.0030

Chan, R. C. K., Shum, D., Toulopoulou, T., & Chen, E.Y.H. (2008). Assessment of executive functions: Review of instruments and identification of critical issues. *Archives of Clinical Neuropsychology, 23*, 201-216. doi: http://dx.doi.org/10.1016/j.acn.2007.08.010

Chaytor, N., & Schmitter-Edgecombe, M. (2003). The Ecological Validity of Neuropsychological Tests: A Review of the Literature on Everyday Cognitive Skills. *Neuropsychology Review*, *13*, 181-197. doi: 10.1023/B:NERV.0000009483.91468.fb

Chiu, K. S., Carlson, R. A., Arnett, P. A., Cosentino, S. A., & Hillary, F. G. (2011). Metacognitive Monitoring in Moderate and Severe Traumatic Brain Injury. *Journal of the International Neuropsychological Society*, 17, 720-731. doi: 10.1017/S1355617711000658

Chua , E. F., Schacter , D. L., Rand-Giovannetti , E., & Sperling , R. A. (2006). Understanding metamemory: Neural correlates of the cognitive process and subjective level of confidence in recognition memory. *NeuroImage*, *29*, 1150-1160. doi: http://dx.doi.org/10.1016/j.neuroimage.2005.09.058

Ciurli, P., Bivona, U., Barba, C., Onder, G., Silvestro, D., Azicnuda, E.,…Formisano, R. (2010). Metacognitive unawareness correlates with executive function impairment after severe traumatic brain injury. *Journal of the International Neuropsychological Society, 16,* 360-368. doi: http://dx.doi.org/10.1017/S135561770999141X

Clare, L., Wilson, B. A., Carter, G., Roth, I., & Hodges, J., R. (2004). Awareness in Early Stage Alzheimer's Disease: Relationship to Outcome of Cognitive Rehabilitation.

Journal of Clinical and Experimental Neuropsychology, *26*, 215-226. Doi: 10.1076/jcen.26.2.215.28088

Collette, F., Hogge, M., Salmon, E., & Van der Linden, M. (2006). Exploration of the neural substrates of executive functioning by functional neuroimaging, *Neuroscience*, *139,* 209-221. doi: http://dx.doi.org/10.1016/j.neuroscience.2005.05.035

Cosentino, S., & Stern, T. (2005). Metacognitive theory and assessment in dementia: Do we recognize our areas of weakness?. *Journal of the International Neuropsychological Society*, *11*, 910-919. doi: 10.10170S1355617705050964

Crosson, B., Barco, P. P., Velozo, C. A., Bolesta, M. M., Cooper, P. V., Werts, D.,…Brobeck, T. C. (1989). Awareness and compensation in postacute head injury rehabilitation. *The Journal of Head Trauma Rehabilitation*, *4*(3), 46-54. doi: 10.1097/00001199 198909000-00008

Cutting, J. (1978). Study of anosognosia. *Journal of Neurology, Neurosurgery & Psychiatry, 41*, 548-555. doi:10.1136/jnnp.41.6.548

Deaton, A. V. (1986). Denial in the aftermath of traumatic head injury: Its manifestations, measurement, and treatment. *Rehabilitation Psychology*, *31*, 231-240. doi: 10.1037/h0091550

Ekstam, L., Uppgard, B., Kottorp, A., & Tham, K. (2007). Relationship between awareness of disability and occupational performance during the first year after a stroke. *American Journal of Occupational Therapy, 61*, 503–511. doi: 10.5014/ajot.61.5.503

Erez, A. B-H., Rothschild, E., Katz, N., Tuchner, M., & Hartman-Maeir, A. (2009). Executive functioning, awareness, and participation in daily life after mild traumatic brain injury: A preliminary study. *American Journal of Occupational Therapy*, *63,* 634–640. doi: 10.5014/ajot.63.5.634

Fernandez-Duque, D., Baird, J. A., Posner, M. I. (2000). Executive Attention and Metacognitive Regulation, *Consciousness and Cognition*, *9,* 288-307. doi: http://dx.doi.org/10.1006/ccog.2000.0447

Finfer, S. R., & Cohen, J. (2001). Severe traumatic brain injury. *Resuscitation*, *48*(1), 77-90. doi: http://dx.doi.org/10.1016/S0300-9572(00)00321-X

Fisk, G. D., Owsley, C., Pulley, L. V. (1997). Driving after stroke: Driving exposure, advice, and evaluations. *Archives of Physical Medicine and Rehabilitation*, *78,* 1338-1345. doi: http://dx.doi.org/10.1016/S0003-9993(97)90307-5

Flavell, J. H. (1979). Metacognition and cognitive monitoring: A new area of cognitive developmental inquiry. *American Psychologist*, *34,* 906-911. doi: 10.1037/0003 066X.34.10.906

Fleming, J. M., Strong, J., & Ashton, R. (1996). Self-awareness of deficits in adults with traumatic brain injury: how best to measure?. *Brain Injury, 10*(1), 1-15. doi:10.1080/026990596124674

Fleming, J. M., & Ownsworth, T. (2006). A review of awareness interventions in brain injury rehabilitation. *Neuropsychological Rehabilitation: An International Journal*, *16,* 474 500. doi: 10.1080/09602010500505518

Formisano, R., Bivona, U., Brunelli, S., Giustini, M., Longo, E., & Taggi F. (2005). A preliminary investigation of road traffic accident rate after severe brain injury. *Brain Injury*, *19*, 159-163. doi:10.1080/02699050400017163

Forskrift om helsekrav til bilførere mv (1984). *Forskrift om leges melding om at innehaveren av flysertifikat eller førerkort ikke fyller helsemessige krav. nr 1467, § 2.* Retrieved from Lovdata http://www.lovdata.no/cgi-wift/ldles?doc=/sf/sf/sf 198407131467.html

Førerkortforskriften (2004). *Forskrift om førerkort m.m. nr. 298, Vedlegg 1 – Helsekrav, § 2.4.* Retrieved from Lovdata http://www.lovdata.no/cgiwift/ldles?doc=/sf/sf/sf 20040119-0298.html

Gioia, G. A., Isquith, P. K., Guy, S. C., & Kenworthy, L. (2000). TEST REVIEW Behavior Rating Inventory of Executive Function, *Child Neuropsychology*, *6*, 235-238. doi: 10.1076/chin.6.3.235.3152

Gioia, G. A., & Isquith, P., K. (2004). Ecological Assessment of Executive Function in Traumatic Brain Injury. *Developmental Neuropsychology, 25*, 135-158. doi: 10.1080/87565641.2004.9651925

Grafman J., & Litvan, I. (1999). Importance of deficits in executive functions. *The Lancet, 354*, 1921-1923. doi:10.1016/S0140-6736(99)90438-5

Griffen, J. A., Rapport, L. J., Coleman Bryer, R., Bieliauskas, L. A., & Burt, C. (2011). Awareness of Deficits and On-Road Driving Performance. *The Clinical Neuropsychologist, 25*, 1158-1178. doi: 10.1080/13854046.2011.609841

Gusnard, D. A., & Raichle, M. E. (2001). Searching for a baseline: Functional imaging and the resting human brain. *Nature Reviews Neuroscience*, *2*, 685-694. doi: 10.1038/35094500

Hart, T., Giovannetti, T., Montgomery, M. W., & Schwartz, M. F. (1998). Awareness of errors in a naturalistic action after traumatic brain injury. *Journal of Head Trauma Rehabilitation, 13*(5), 16-28. doi: 10.1097/00001199-199810000-00004

Hart, T., Whyte, J., Kim, J., & Vaccaro, M. (2005). Executive Function and Self-awareness of "Real-world" Behavior and Attention Deficits Followin Traumatic Brain Injury. *Journal of Head Trauma Rehabilitation*, *20*, 333-347. Retrieved from http://ovidsp.uk.ovid.com, AN: 00001199-200507000-00005

Hartman-Maeir, A., Soroker, N., Ring, H., & Katz, N. (2000). Awareness of deficits in stroke rehabilitation. *J Rehabil Med*, *34,* 158–164. doi: 10.1080/16501970213236

Haselkorn, J, K., Mueller, B., A., & Rivara, F., A. (1998). Characteristics of Drivers and Driving Record After Traumatic and Nontraumatic Brain Injury. *Arch Phys Med Rehabil, 79,* 738-742. doi: http://dx.doi.org/10.1016/S0003-9993(98)90349-5

Harwood, D. G., Sultzer, D. L., Feil, D., Monserrat, L., Freedman, E., & Mandelkern, M. A. (2005). Frontal lobe hypometabolism and impaired insight in Alzheimer disease. *Am J Geriatr Psychiatry, 13,* 934-941. Retrieved from http://ovidsp.uk.ovid.com, AN: 00019442-200511000-00003

Helsepersonelloven. (1999). *Lov om helsepersonell m.v. av 2. juli 1999 nr. 64, § 34.*

House, A., & Hodges J. (1988). Persistent denial of handicap after infarction of the right basal ganglia: a case study. *Journal of Neurology, Neurosurgery & Psychiatry, 51*, 112-115. doi:10.1136/jnnp.51.1.112

Johnson, S., C., Baxter, L., C., Wilder, L., S., Pipe, J., G., Heiserman, J, E., & Prigatano, G., P. (2002). Neural correlates of self-reflection. *Brain*, *125*, 1808-1814. doi: 10.1093/brain/awf181

Jurado, M. B., & Rosselli, M. (2007). The Elusive Nature of Executive Functions: A Review of our Current Understanding. *Neuropsychol Rev*, *17*, 213-233. doi: 10.1007/s11065 007-9040-z

Karpicke, J. D. (2009). Metacognitive control and strategy selection: Deciding to practice retrieval during learning. *Journal of Experimental Psychology 138*, 469-486. doi: 10.1037/a0017341

Kelley, W. M., Macrae, C. N., Wyland, C. L., Caglar, S., Inati, S., & Heatherton, T. F. (2002). Finding the self? An Event-Related fMRI Study. *Journal of Cognitive Neuroscience*, *14*, 785-794. doi:10.1162/08989290260138672

Kortte, K.B., Chwalisz, K. & Wegener, S.T. (2003). Anosognosia & Denial: Their relationship to Coping and Depression in Aqcuired Brain Injury. *Rehabilitation Psychology*, *48*, 131-136. doi: 10.1037/0090-5550.48.3.131

Leathem, J. M., Murphy, L. J., Flett. R. A. (1998). Self- and Informant-Ratings on the Patient Competency Rating Scale in Patients with Traumatic Brain Injury. *Journal of Clinical and Experimental Neuropsychology, 20*, 694-705. doi: 10.1076/jcen.20.5.694.1122

Lewis, S. J. G., Dove, A., Robbins, T. W., Barker, R. A. and Owen, A. M. (2004), Striatal contributions to working memory: a functional magnetic resonance imaging study in humans. *European Journal of Neuroscience*, *19*, 755–760. doi: 10.1111/j.1460 9568.2004.03108.x

Lezak, M. D. (2004). *Neuropsychological assessment* (4th ed.). New York: Oxford University Press.

Lundberg, C., Caneman, G., Samuelsson, S-M., Hakamies-Blomquist, L., & Almkvist, O. (2003). The assessment of fitness to drive after a stroke: The Nordic Stroke Driver Screening Assessment. *Scandinavian Journal of Psychology*, *44*(1), 23–30. doi: 10.1111/1467-9450.00317

Lundquist A. (2001). *Cognitive functions in drivers with brain injury - anticipation and adaptation. Neuropsychological aspects of driving after brain lesion*. (Doctoral Dissertation, Lindköpings Universitet, Sweeden). Retrieved from http://liu.diva portal.org/smash/record.jsf?pid=diva2:21067

Lundqvist, A., & Alinder, J. (2007). Driving after brain injury: Self-awareness and coping at the tactical level of control. *Brain Injury, 21*. 1109-1117. doi: 10.1080/02699050701651660

Lysaker, P. H., Warman, D. M., Dimaggio, G., Procacci, M., LaRocco, V. A., Clark, L. K.,… Nicolò, G. (2008). Metacognition in Schizophrenia: Associations With Multiple Assessments of Executive Function. *The Journal of Nervous and Mental Disease, 196,* 384-389. doi: 10.1097/NMD.0b013e3181710916

Løvstad, M., Funderud, I., Endestad, T., Due-Tønnesen, P., Meling, T. R., Lindgren, M.,…Solbakk, A. K. (In press). Executive functions after orbital or lateral prefrontal lesions: Neuropsychological profiles and self-reported executive functions in everyday living. *Brain Injury*, Doi: 10.3109/02699052.2012.698787

Maas, A., R., Stocchetti, N., & Bullock, R. (2008). Moderate and severe traumatic brain injury in adults. *Lancet Neurology*, *7*, 728-741. doi: http://dx.doi.org/10.1016/S1474 4422(08)70164-9

Malec, J. F., Machulda, M. M., Moessner, A. M. (1997). Differing problem perceptions of staff, survivors, and significant others after brain injury. *The Journal of Head Trauma Rehabilitation*, *12*(3), 1-13. doi: 10.1097/00001199-199706000-00002

Marcel, A. J., Tegnér, R., & Nimmo-Smith, I. (2004). Anosognosia for Plegia: Specificity, Extension, Partiality and Disunity of Bodily Unawareness. *Cortex*, *40*(1), 19-40. doi: http://dx.doi.org/10.1016/S0010-9452(08)70919-5

Marshall, S. C., Molnar, F., Man-Son-Hing, M., Blair, R., Brosseau, L., Finestone, H. M.,…Wilson, K. G. (2007). Predictors of Driving Ability Following Stroke: A Systematic Review. *Topics in Stroke Rehabilitation*, *14*(1), 98-114. doi: 10.1310/tsr1401-98

McAuley, T., Chen, S., Goos, L., Schachar, R., & Crosbie, J. (2010). Is the behavior rating inventory of executive function more strongly associated with measures of impairment or executive function?. *Journal of the International Neuropsychological Society*, *16*, 495-505. doi: http://dx.doi.org/10.1017/S1355617710000093

McCrae, R. R., Stone, S. V., Fagan, P. J., & Costa, P. T. Jr. (1998). Identifying Causes of Disagreement Between Self-Reports and Spouse Ratings of Personality. *Journal of Personality, 66*, 285-313. doi. 10.1111/1467-6494.00013

Michon, J. A. (1985). A critical view of driver behaviour models: What do we know, what should we do? L. Evans & R. C. Schwing (Eds.). *Human behavior and traffic safety.* (pp. 485-520). New York: Plenum Press. (Paper presented at a General Motors Symposium at the GM Research Laboratories, Warren Michigan). Retrieved from http://www.jamichon.nl/jam_writings/1985_criticial_view.pdf

Moro, V., Pernigo, S., Zapparoli, P., Cordioli, Z., & Aglioti, S. M. (2011). Phenomenology and neural correlates of implicit and emergent motor awareness in patients with anosognosia for hemiplegia. *Behavioral Brain research*, *225*, 259-269. doi: http://dx.doi.org/10.1016/j.bbr.2011.07.010

Neyens, D. M., & Boyle, L. N. (2012). Crash risk factors related to individuals sustaining and drivers following traumatic brain injuries. *Accident Analysis and Prevention*, *49*, 266-273. doi: http://dx.doi.org/10.1016/j.aap.2012.01.008,

Norsk Psykologforening (2012). *Norsk Psykologforenings faglige veileder i førerkortsaker. Regelverk, evidens og praksis*. Retrieved from: http://www.psykologforeningen.no/Fag-og-profesjon/For fagutoevere/Fag/Foererkortveileder

O'Keeffe, F., Dockree, P., Moloney, P., Carton, S., & Robertson, I. H. (2007). Awareness of deficits in traumatic brain injury: A multidimensional approach to assessing metacognitive knowledge and online-awareness. *Journal of International Neuropsychological Society, 13*(1), 38-49. doi: http://dx.doi.org/10.1017/S1355617707070075

Ownsworth, T. L., McFarland, K., & Young, R. M. (2002). The investigation of factors underlying deficits in self-awareness and self-regulation. *Brain injury, 16*, 291-309. doi: 10.1080/02699050110103986

Patomella, A-H., Kottorp, A., & Tham, K. (2008). Awareness of driving disability in people with stroke tested in a simulator. *Scandinavian Journal of Occupational Therapy, 15*, 184-192. doi:10.1080/11038120802087600

Pietrapiana, P., Tamietto, M., Torrini, G., Mezzanato, T., Rago, R., & Perino, C. (2005). Role of premorbid factors in predicting safe return to driving after severe TBI. *Brain Injury, 19*, 197–211. doi:10.1080/02699050400017197

Prigatano, G. P. (1996) Behavioral limitations TBI patients tend to underestimate: A replication and extension to patients with lateralized cerebral dysfunction. *Clinical neuropsychologist*, *10*, 191-201. doi: 10.1080/13854049608406680

Prigatano, G. P., Altman, I. M., & O'Brien, K. P. (1990). Behavioral limitations that brain injured patients tend to underestimate. *Clinical neuropsychologist*, *4*, 163-176. doi: 10.1080/13854049008401509

Prigatano, G. P., & Klonoff, P. S. (1998). A Clinician's Rating Scale for Evaluating Impaired Self-Awareness and Denial of Disability After Brain Injury. *The Clinical Neuropsychologist, 12*(1), 56-67. doi: 10.1076/clin.12.1.56.1721

Raichle, M. E., MacLeod, A. M., Snyder, A. Z., Powers, W. J., Gusnard, D. A., & Shulman, G. L. (2001). A default mode of brain function. *PNAS, 98*, 676-682. doi: 10.1073/pnas.98.2.676

Rosen, H. (2011). Anosognosia in neurodegenerative disease. *Neurocase, 17*, 231-241. doi: 10.1080/13554794.2010.522588

Rosen, H.J., Alcantar, O., Rothlind, J., Sturm, V., Kramer, J.H., Weiner, M.,…Miller, B. L., (2010). Neuroanatomical correlates of cognitive self-appraisal in neurodegenerative disease. *NeuroImage*, *49*, 3358-3364. doi: http://dx.doi.org/10.1016/j.neuroimage.2009.11.041

Roth, R.M., Isquith, P.K., & Gioia, G.A. (2005). BRIEF-A: Behavior Rating Inventory of Executive Function - Adult Version. Lutz, FL: Psychological Assessment Resources.

Royall, D.R., Lauterbach, E.C., Cummings, J.L., Reeve, A., Rummans, T. A., Kaufer D.I.,…Coffey, C. E. (2002). Executive control function: A review of its promise and challenges for clinical research. A report from the Committee on Research of the American Neuropsychiatric Association. *Journal of Neuropsychiatry and Clinical Neuroscience*, *14*, 377-405. doi: 10.1176/appi.neuropsych.14.4.377

Salmon, E., Perani, D., Herholz, K., Marique, P., Kalbe, E., Holthoff, V.,...Garraux, G. (2006). Neural correlates of anosognosia for cognitive impairment in Alzheimer's disease. *Hum. Brain Mapp., 27*, 588–597. doi: 10.1002/hbm.20203

Schanke, A.-K., Rike, P.-O., Mølmen, A. & Østen, P.-E. (2008). Driving behaviour after brain injury: A follow up of accident rate and driving patterns 6-9 years post-injury. *J Rehabil Med*, *40*, 733-736. doi: 10.2340/16501977-0256

Schanke, A.-K., & Sundet, K. (2000). Comprehensive driving assessment: Neuropsychological testing and on-road evaluation of brain injured patients. *Scandinavian Journal of Psychology*, *41*(2), 113-121. doi: 10.1111/1467-9450.00179

Schmitz, T. W., Kawahara-Baccus, T.N., & Johnson, S. C. (2004). Metacognitive evaluation, self-relevance, and the right prefrontal cortex. *NeuroImage*, *22*, 941-947. doi: http://dx.doi.org/10.1016/j.neuroimage.2004.02.018

Schmitz, T.W., Rowley, H.A., Kawahara, T.N., & Johnson, S.C. (2006). Neural correlates of self-evaluative accuracy after traumatic brain injury. *Neuropsychologia*, *44*, 762-773. doi: 10.1016/j.neuropsychologia.2005.07.012

Schulteis, M. T., Matheis, R. J., Nead, R., & DeLuca, J. (2002). Driving Behaviours Following Brain Injury: Self-Report and Motor Vehicle Records. *Journal of Head* *trauma Rehabilitation*, *17*(1), 38-47. Retrieved from http://ovidsp.uk.ovid.com, AN: 00001199-200202000-00006

Scott, C. A. (2010). *Awareness Of Deficit And Driving Simulator Performance After Stroke.* (Doctoral Dissertation, Wayne State University, Detroit). Retrieved from http://digitalcommons.wayne.edu/oa_dissertations/131/

Scott, C. A., Rapport, L. J., Coleman Bryer, R., Griffen, J., Hanks, R., & McKay, C. (2009). Self-assessment of driving ability and the decision to resume driving following stroke. *Journal of Clinical and Experimental Neuropsychology*, *31*, 353-362. Doi: 10.1080/13803390802169067

Sharp, D. J., Beckmann, C. F., Greenwood, R., Kinnunen, K. M., Bonnelle, V., De Boissezon, X.,…Leech, R. (2011). Default mode network functional and structural connectivity after traumatic brain injury. *Brain*, *134*, 2233-2247. doi: 10.1093/brain/awr175

Sherer, M., Hart, T., & Nick, T.G. (2003). Measurement of impaired self-awareness after traumatic brain injury: a comparison of the patient competency rating scale and the awareness questionnaire. *Brain Injury, 17*(1), 25-37. doi:10.1080/0269905021000010113

Sherer, M., Hart, T., Whyte, J., Nick, T.G., & Yablon, S.A. (2005). Neuroanatomic basis of impaired self-awareness after traumatic brain injury: Findings from early computed tomography. *Journal of head trauma and rehabilitation*, *20*, 287-300. Retrieved from http://ovidsp.uk.ovid.com, AN: 00001199-200507000-00002

Sherer, M., Bergloff, P., Levin, E., High, W.M. jr., Oden, K.E., & Nick, T.G. (1998). Impaired awareness and employment outcome after traumatic brain injury. *Journal of head trauma and rehabilitation*, *13*(5), 52-61. doi: 10.1097/00001199-199810000 00007

Sherer, M., Bergloff, P., Boake, C., High, W. M. jr., & Levin, E. (1998). The Awareness Questionnaire: factor structure and internal consistency. *Brain Injury*, *12*(1), 63-68. doi:10.1080/026990598122863 (Løvstad, M., Solbakk, A-K., Schanke, A-K., & Schanche, S., (2007). Norwegian Translation with permission from the authors).

Sherer M., Boake C., Levin E., Silver B.V., Ringholz G., & High WM Jr. (1998). Characteristics of impaired awareness after traumatic brain injury. *Journal of International Neuropsychological Society*, *4*, 380-387. doi: http://dx.doi.org/

Shimamura, A. P. (2000). Toward a Cognitive Neuroscience of Metacognition, *Consciousness and Cognition*, *9*, 313-323. doi: http://dx.doi.org/10.1006/ccog.2000.0450

Shulman, G. L., Fiez, J. A., Corbetta, M., Buckner, R. L., Miezin, F. M., Raichle, M. E.,…Petersen, S. E. (1997). Common Blood Flow Changes across Visual Tasks: II. Decreases in Cerebral Cortex. *Journal of Cognitive Neuroscience, 9*, 648-663. doi:10.1162/jocn.1997.9.5.648

Smith-Arena, L., Edelstein, L., & Rabadi, M. H. (2006). Predictors of Successful Driver Evaluation in Stroke Patients After Discharge Based on an Acute Rehabilitation Hospital Evaluation. *American Journal of Physical Medicine & rehabilitation*, *85*(1), 44-52. Retrieved from http://ovidsp.uk.ovid.com, AN: 00002060-200601000-00007

Starkstein, S. E., Jorge, R. E., & Robinson, R. G. (2010). The Frequency, Clinical Correlates and Mechanism of Anosognosia After Stroke. *Canadian Journal of Psychiatry, 55*(6), 355-361. Retrieved from http://search.proquest.com/docview/609122190?accountid=14699

Statistics Norway (2012, 01. 06). *Veitrafikkulykker med personskade, endelige tall 2011*. Retrieved from http://www.ssb.no/vtuaar/

Stuss, D. T. (1987). Contribution of frontal lobe injury to cognitive impairment after closed head injury: Methods of assessment and recent findings. In Levin, H., S., Grafman, J., Eisenberg, H., M. (eds.), *Neurobehavioral Recovery from Head Injury* (pp 166-177) New York. Oxford University Press. Retrieved from

http://www.google.no/books?hl=en&lr=&id=tRoF2cLIEz4C&oi=fnd&pg=PA166&d=Stuss,+D.+T.+(1987).+Contribution+of+frontal+lobe+injury+to+cognitive+impairent+after+closed&ots=i_DR3YxSSd&sig=1EYarZISuixz2WxVyZge1HIIE0&redir_esc=y#v=onepage&q&f=false

Stuss, D. T. (2011). Functions of the Frontal Lobes: Relation to Executive Functions. *Journal of the International Neuropsychological Society*, *17*(5), 1-7. doi: http://dx.doi.org/10.1017/S1355617711000695

Stuss, D. T., & Alexander, M. P. (2000). Executive functions and the frontal lobes: a conceptual view. *Psychological Research, 63,* 289-298. doi: 10.1007/s004269900007

Stuss, D. T., & Buckle, L. (1992). Traumatic brain injury: Neuropsychological deficits and evaluation at different stages of recovery and in different pathologic subtypes. *Journal of Head Trauma Rehabilitation*, *7*(2), 40-49. Retrieved from http://ovidsp.uk.ovid.com, AN: 00001199-199206000-00007

Stuss, D.T., & Levine, B. (2002). Adult clinical neuropsychology: Lessons from Studies of the Frontal Lobes. *Annu. Rev. Psychol*., *53*, 401–33. doi: 10.1146/annurev.psych.53.100901.135220

Stuss, D. T., Shallice, T., Alexander, M. P., & Picton, T, W. (1995). A Multidisciplinary Approach to Anterior Attentional Functions. *Annals of the New York Academy of Sciences*, *769*, 191-212. doi: 10.1111/j.1749-6632.1995.tb38140.x

Sundet, K., Goeffeng, L., & Hofft, E. (1995). To drive or not to drive: Neuropsychological assessment for driver's licence among stroke patients. *Scandinavian Journal of Psychology*, *36*(1), 47-58. doi: 10.1111/j.1467-9450.1995.tb00967.x

Tamietto, M., Torrini, G., Adenzato, M., Pietrapiana, P., Rago, R., Perino, C. (2006). To drive or not to drive (after TBI)? A review of the literature and its implications for rehabilitation and future research. *NeuroRehabilitation*, *21*(1), 81-92. Retrieved from http://www.researchgate.net/publication/7061655_To_drive_or_not_to_drive_%28after_TBI%29_A_review_of_the_literature_and_its_implications_for_rehabilitation_and_future_research

Toglia, J., & Kirk, U. (2000). Understanding awareness deficits following brain injury. *NeuroRehabilitation*, *15*(1), 57-70. Retrieved from http://iospress.metapress.com/content/cllr7p55emtmbfma/fulltext.pdf

Van Zomeren, A. H., Brouwer, W. H., & Minderhoud, J. M. (1987). Aquired Brain Damage and Driving: A Review, *Archives of Physical Medicine and Rehabilitation, 68*, 607 705. Retrieved from: http://cogrehab.com/resources/vanZomerenetal.pdf

Xu, J., Rasmussen, I-A., Lagopoulos, J., & Håberg, A. (2007). Diffuse Axonal Injury in Severe Traumatic Brain Injury Visualized Using High-Resolution Diffusion Tensor Imaging. *Journal of Neurotrauma, 24*, 753-765. doi: 10.1089/neu.2006.0208

Appendices

Appendix 1. The Awareness Questionnaire, Norwegian version

Appendix 1.1. Awareness Questionnaire Patient form

Awareness Questionnaire

Pasientskjema

Navn:__________________________ **Pasient nummer:**__________ **Dato:**____________

1	2	3	4	5
mye dårligere	litt dårligere	omtrent det samme	litt bedre	mye bedre

____ 1. Hvor god er din evne til å leve selvstendig nå sammenlignet med før skaden din?

____ 2. Hvor god er din evne til å håndtere pengene dine nå sammenlignet med før skaden din?

____ 3. Hvor godt kommer du overens med folk nå sammenlignet med før skaden din?

____ 4. Hvor godt kan du prestere på tester som måler evnen til å tenke og huske nå sammenlignet med før skaden din?

____ 5. Hvor godt kan du gjøre de tingene du vil i livet nå sammenlignet med før skaden din?

____ 6. Hvor godt ser du nå sammenlignet med før skaden din?

____ 7. Hvor godt hører du nå sammenlignet med før skaden din?

____ 8. Hvor godt kan du bevege armene og bena dine nå sammenlignet med før skaden din?

____ 9. Hvor god er din koordineringsevne nå sammenlignet med før skaden din?

____ 10. Hvor god er du til å holde oversikt over tiden, datoen og hvor du er nåsammenlignet med før skaden din?

____ 11. Hvor godt kan du konsentrere deg nå sammenlignet med før skaden din?

1	2	3	4	5
mye dårligere	**litt dårligere**	**omtrent det samme**	**litt bedre**	**mye bedre**

____ 12. Hvor godt kan du uttrykke tankene dine til andre nå sammenlignet med før skaden din?

____ 13. Hvor god er hukommelsen din for ting som nylig har skjedd nå sammenlignet med før skaden din?

____ 14. Hvor god er du til å planlegge ting nå sammenlignet med før skaden din?

____ 15. Hvor god er du til å organisere deg nå sammenlignet med før skaden din?

____ 16. Hvor godt kan du kontrollere følelsene dine nå sammenlignet med før skaden din?

____ 17. Hvor emosjonelt veltilpasset er du nå sammenlignet med før skaden din?

Awareness Questionnaire (Sherer, M., Bergloff, P., Boake, C., High, W. & Levin, E. (1998). The Awareness Questionnaire: factor structure and internal consistency. *Brain Injury, 12,* 63-68). Oversatt til norsk med tillatelse fra forfatterne av Marianne Løvstad, Anne-Kristin Solbakk, Anne-Kristine Schanke og Susan Schanche.

Appendix 1.2. Awareness Questionnaire Relative form

Awareness Questionnaire

Pårørendeskjema

Navn:____________________________ **Relasjon til pasienten:**______________

Pasient:__________________________ **Pasient nummer:**__________ **Dato:**____________

1	2	3	4	5
mye dårligere	**litt dårligere**	**omtrent det samme**	**litt bedre**	**mye bedre**

____ 1. Hvor god er pasientens evne til å leve selvstendig nå sammenlignet med før hans/hennes skade?

____ 2. Hvor god er pasientens evne til å håndtere pengene sine nå sammenlignet med før hans/hennes skade?

____ 3. Hvor godt kommer pasienten overens med folk nå sammenlignet med før hans/hennes skade?

____ 4. Hvor godt kan pasienten prestere på tester som måler evnen til å tenke og huske nå, sammenlignet med før hans/hennes skade?

____ 5. Hvor godt kan pasienten gjøre de tingene han/hun vil i livet nå sammenlignet med før hans/hennes skade?

____ 6. Hvor godt ser pasienten nå sammenlignet med før hans/hennes skade?

____ 7. Hvor godt hører pasienten nå sammenlignet med før hans/hennes skade?

____ 8. Hvor godt kan pasienten bevege armene og bena sine nå sammenlignet med før hans/hennes skade?

____ 9. Hvor god er pasientens koordineringsevne nå sammenlignet med før hans/hennes skade?

____ 10. Hvor god er pasienten til å holde oversikt over tiden, datoen og hvor han/hun er nå sammenlignet med før hans/hennes skade?

____ 11. Hvor godt kan pasienten konsentrere seg nå sammenlignet med før hans/hennes skade?

1	2	3	4	5
mye dårligere	**litt dårligere**	**omtrent det samme**	**litt bedre**	**mye bedre**

____ 12. Hvor godt kan pasienten uttrykke tankene sine til andre nå sammenlignet med før hans/hennes skade?

____ 13. Hvor god er pasientens hukommelse for ting som nylig har skjedd nå sammenlignet med før hans/hennes skade?

____ 14. Hvor god er pasienten til å planlegge ting nå sammenlignet med før hans/hennes skade?

____ 15. Hvor god er pasienten til å organisere seg nå sammenlignet med før hans/hennes skade?

____ 16. Hvor godt kan pasienten kontrollere følelsene sine nå sammenlignet med før hans/hennes skade?

____ 17. Hvor emosjonelt veltilpasset er pasienten nå sammenlignet med før hans/hennes skade?

Awareness Questionnaire (Sherer, M., Bergloff, P., Boake, C., High, W. & Levin, E. (1998). The Awareness Questionnaire: factor structure and internal consistency. *Brain Injury, 12,* 63-68). Oversatt til norsk med tillatelse fra forfatterne av Marianne Løvstad, Anne-Kristin Solbakk, Anne-Kristine Schanke og Susan Schanche.

Appendix 2. Distribution of discrepancy scores on Awareness Questionnaire and BRIEF-A

Figure 2.1. Distribution of Awareness Questionnaire (AQ) discrepancy scores

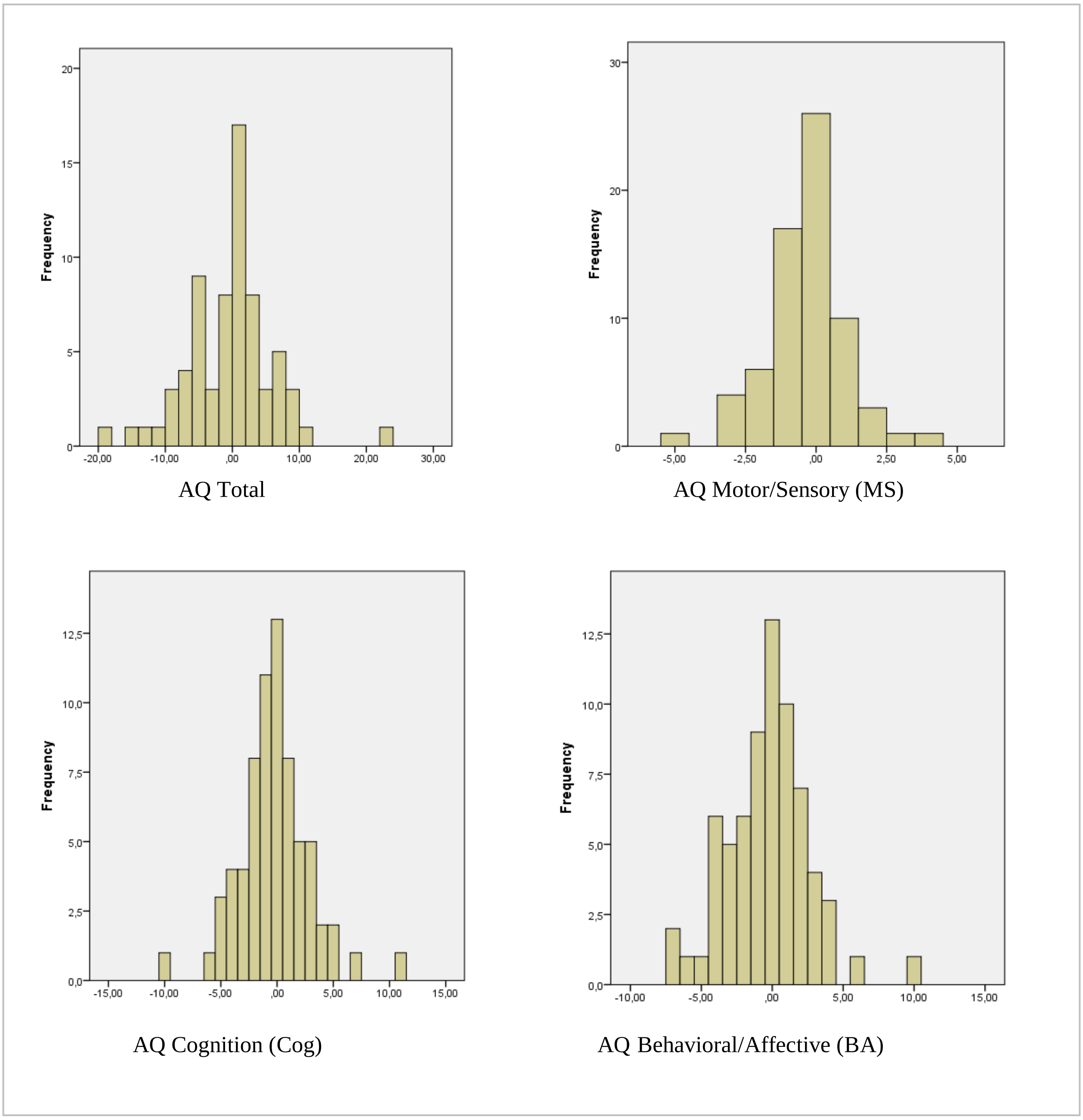
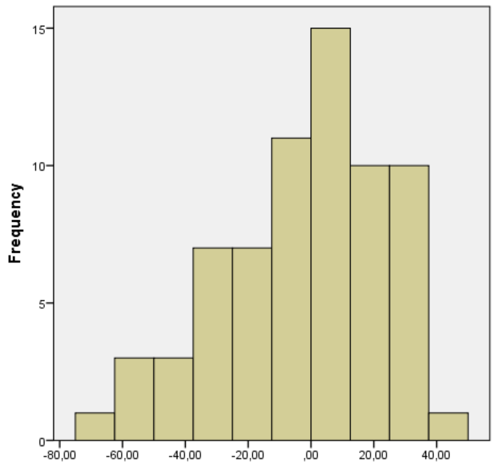
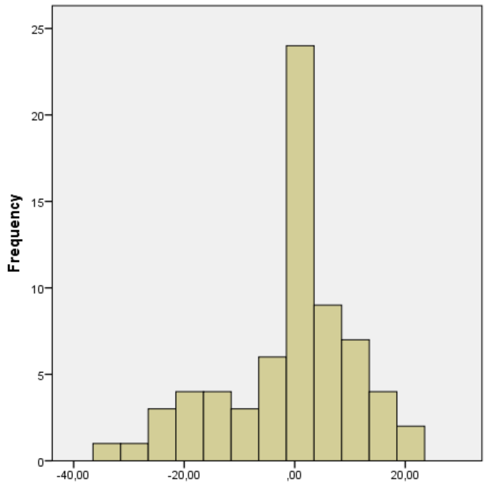
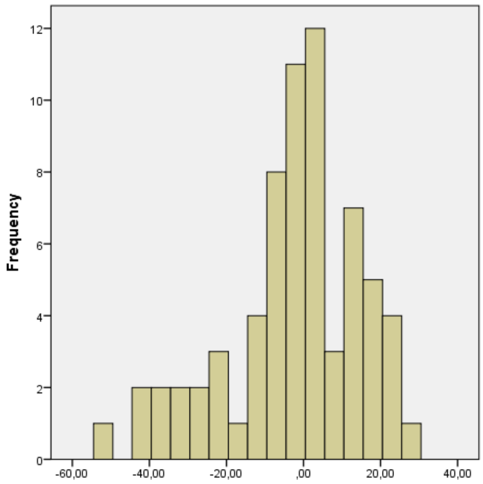


Figure 2.2. Distribution of Behavior Rating Inventory of Executive Function (BRIEF-A) discrepancy scores



BRIEF-A Global Executive Composite (GEC)





BRIEF-A Behavior Regulation Index (BRI)

BRIEF-A Metacognitiv Index (MI)

Appendix 3. Group differences between the group of patients fulfilling criteria for driving and the group of patients *not* fulfilling criteria for driving

Appendix 3.1. Group differences on the Awareness Questionnaire discrepancy scores.

Positive discrepancy scores re-coded to the value zero, t-test for independent samples. Mann-Whitney U-test showed equivalent results.

Table 3.1. *Group differences between the group of patients fulfilling criteria for driving and the group of patients not fulfilling criteria for driving on the Awareness Questionnaire discrepancy scores.*

	Fulfilled criteria for driving						
Awaraness Questionnaire	**No**			**Yes**			
Discrepancy scores	*n*	Mean	*SD*	*n*	Mean	*SD*	*p*
Total	29	-3,3	4,8	40	-2,4	4,0	0,41
MS	29	-0,8	1,1	40	-0,6	1,0	0,53
Cog	29	-1,5	2,0	40	-1,1	1,9	0,46
BA	29	-0,4	3,3	40	-0,2	2,7	0,79

Note. MS: Motor/Sensory, Cog: Cognition, BA: Behavioral/Affective

Appendix 3.2. Group differences on the BRIEF-A discrepancy scores.

Positive discrepancy scores re-coded to the value zero, t-test for independent samples. Mann-Whitney U-test showed equivalent results.

Table 3.2. *Group differences between the group of patients fulfilling criteria for driving and the group of patients not fulfilling criteria for driving on the BRIEF-A discrepancy scores.*

	Fulfilled criteria for driving						
BRIEF-A	**No**			**Yes**			
Discrepancy scores	*n*	Mean	*SD*	*n*	Mean	*SD*	*p*
BRI	28	-4,8	8,1	40	-4,7	8,7	0,97
MI	28	-11,2	15,1	40	-5,4	10,4	0,06
GEC	28	-14,0	17,4	40	-10,0	17,9	0,37

Note. BRI: Behavioral Regulation Index, MI: Metacognitive Index,
GEC: Global Executive Composite

Appendix 4. The relationship between Localization of injury and Awareness Questinnaire/BRIEF-A

Appendix 4.1. The relationship between Localization of injury and Awareness Questionnaire

Table 4.1. *The relationship between Localization of injury and Awareness Questionnaire: One-way ANOVA*

AQ	Localization	*n*	Mean	*SD*	*p*
Patients' scores					
Total	Left	28	47,3	5,0	,282
	Right	27	44,9	6,4	
	Multifocal	25	46,5	5,4	
	Total	80	46,3	5,6	
MS	Left	28	11,6	,9	**,004** **
	Right	27	10,4	1,6	
	Multifocal	25	10,5	1,5	
	Total	80	10,9	1,5	
Cog	Left	28	18,9	2,5	,646
	Right	27	18,5	3,2	
	Multifocal	25	19,2	2,6	
	Total	80	18,9	2,8	
BA	Left	28	16,9	2,3	,396
	Right	27	16,0	2,9	
	Multifocal	25	16,7	2,5	
	Total	80	16,5	2,5	
Relatives' scores					
Total	Left	24	46,1	4,8	,759
	Right	19	44,5	7,6	
	Multifocal	20	45,7	9,4	
	Total	63	45,5	7,3	
MS	Left	24	11,2	1,2	**,044** *
	Right	19	10,1	1,8	
	Multifocal	20	10,2	1,8	
	Total	63	10,5	1,6	
Cog	Left	24	18,2	2,6	,630
	Right	19	18,9	3,7	
	Multifocal	20	19,3	4,6	
	Total	63	18,7	3,6	
BA	Left	24	16,8	1,9	,377
	Right	19	15,5	2,6	
	Multifocal	20	16,3	4,1	
	Total	63	16,2	3,0	

Table 4.1. *continued.*

Discrepancy scores					
Total	Left	24	-1,3	6,0	,954
	Right	19	-1,0	6,0	
	Multifocal	20	-,7	8,5	
	Total	63	-1,0	6,8	
MS	Left	24	-,4	1,2	,782
	Right	19	-,1	1,1	
	Multifocal	20	-,4	2,0	
	Total	63	-,3	1,4	
Cog	Left	24	-,8	2,9	,556
	Right	19	-,1	3,2	
	Multifocal	20	,2	3,8	
	Total	63	-,3	3,3	
BA	Left	24	-,1	2,8	,701
	Right	19	-,8	2,4	
	Multifocal	20	-,5	3,5	
	Total	63	-,4	2,9	

* $p < 0{,}05$, ** $p < 0{,}01$

Note. MS: Motor/Sensory, Cog: Cognition, BA: Behavioral/Affective

Table 4.1.1. *The relationship between Localization of injury and Awareness Qestionnaire: Post Hoc multiple comparisons (Bonferroni).*

Bonferroni

Dependent Variable	(I) Localization	(J) Localization	Mean Difference (I-J)	Std. Error	*p*
Patients' scores					
Motor/Sensory	Left	Right	1,16	0,37	0,01 **
		Multifocal	1,05	0,38	0,02 *
	Right	Left	-1,16	0,37	0,01 **
		Multifocal	-0,11	0,38	1,00
	Multifocal	Left	-1,05	0,38	0,02 *
		Right	0,11	0,38	1,00

* $p < 0{,}05$, ** $p < 0{,}01$

Appendix 4.2. The relationship between Localization of injury and BRIEF-A

Table 4.2. *The relationship between Localization of injury and BRIEF-A: One-way ANOVA*

BRIEF	Localization	*n*	Mean	*SD*	*p*
Patients' scores					
BRI	Left	28	46,7	9,4	,198
	Right	25	49,5	8,7	
	Multifocal	24	44,8	9,1	
	Total	77	47,0	9,2	
MI	Left	28	46,8	8,1	,595
	Right	25	49,0	10,0	
	Multifocal	24	46,7	9,2	
	Total	77	47,5	9,1	
GEC	Left	28	46,5	8,9	,347
	Right	25	49,2	9,4	
	Multifocal	24	45,5	9,2	
	Total	77	47,1	9,2	
Relatives' scores					
BRI	Left	24	45,5	8,0	,285
	Right	18	49,6	7,8	
	Multifocal	20	48,9	10,9	
	Total	62	47,8	9,0	
MI	Left	24	47,5	9,3	,277
	Right	18	52,1	11,5	
	Multifocal	20	52,4	13,0	
	Total	62	50,4	11,3	
GEC	Left	24	46,5	8,4	,248
	Right	18	51,0	9,0	
	Multifocal	20	50,8	12,4	
	Total	62	49,2	10,1	
Discrepancy scores					
BRI	Left	24	1,0	10,0	,396
	Right	18	-0,8	12,3	
	Multifocal	20	-4,0	13,5	
	Total	62	-1,1	11,9	
MI	Left	24	0,3	13,5	,396
	Right	18	-4,9	20,2	
	Multifocal	20	-6,8	19,5	
	Total	62	-3,5	17,6	
GEC	Left	24	1,2	22,2	,469
	Right	18	-5,7	30,1	
	Multifocal	20	-8,3	27,3	
	Total	62	-3,9	26,2	

* p < 0,05, **p < 0,01

Note. BRI: Behavior/Regulation Index, MI: Metacognitive Index, GEC: Global Executive Composite